SPECIAL AVIATION ISSUE

SCIENTIFIC AMERICAN

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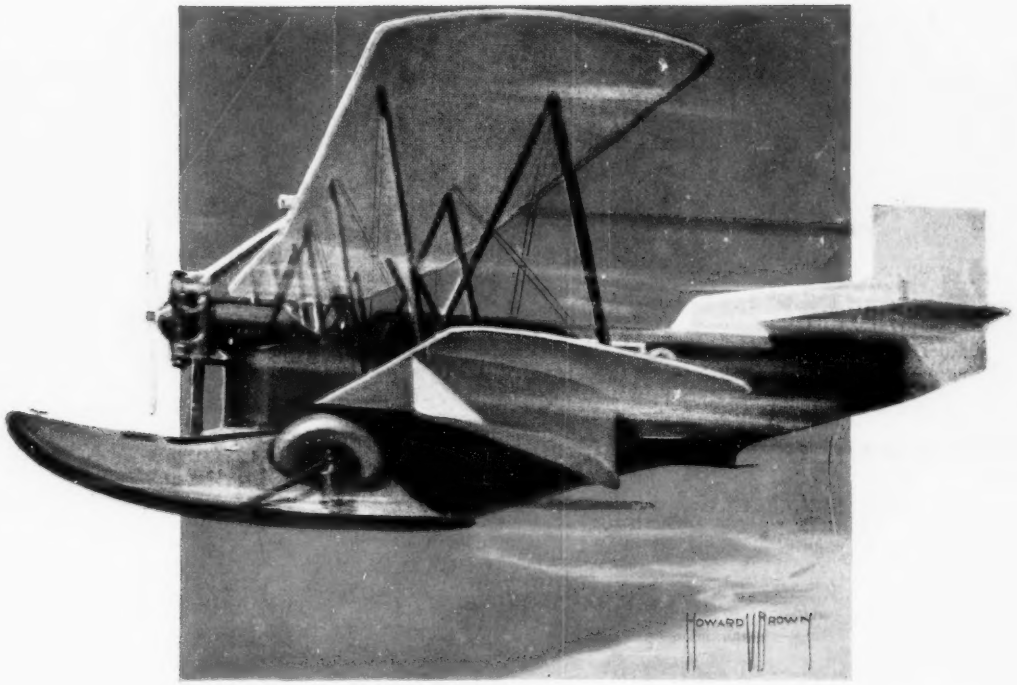


PLANES FOR PRIVATE FLYING

BUILDERS OF THE AVIATION INDUSTRY

HOW TO BUILD A GLIDER

Where Bearing Protection Begins

Into the electric furnaces go the components which later flow out as Timken Steel, the basis of Timken Bearings.

TIMKEN PROTECTION BEGINS HERE—in the steel itself, so totally toughened against wear that it finds no equal for this service.

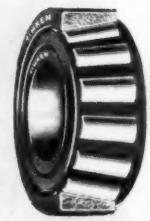
TIMKEN PROTECTION CONTINUES—in motor cars, buses, trucks and industrial machinery. Timken Tapered Roller Bearings provide for true-running gears, shafts and wheels—proof against premature wear.

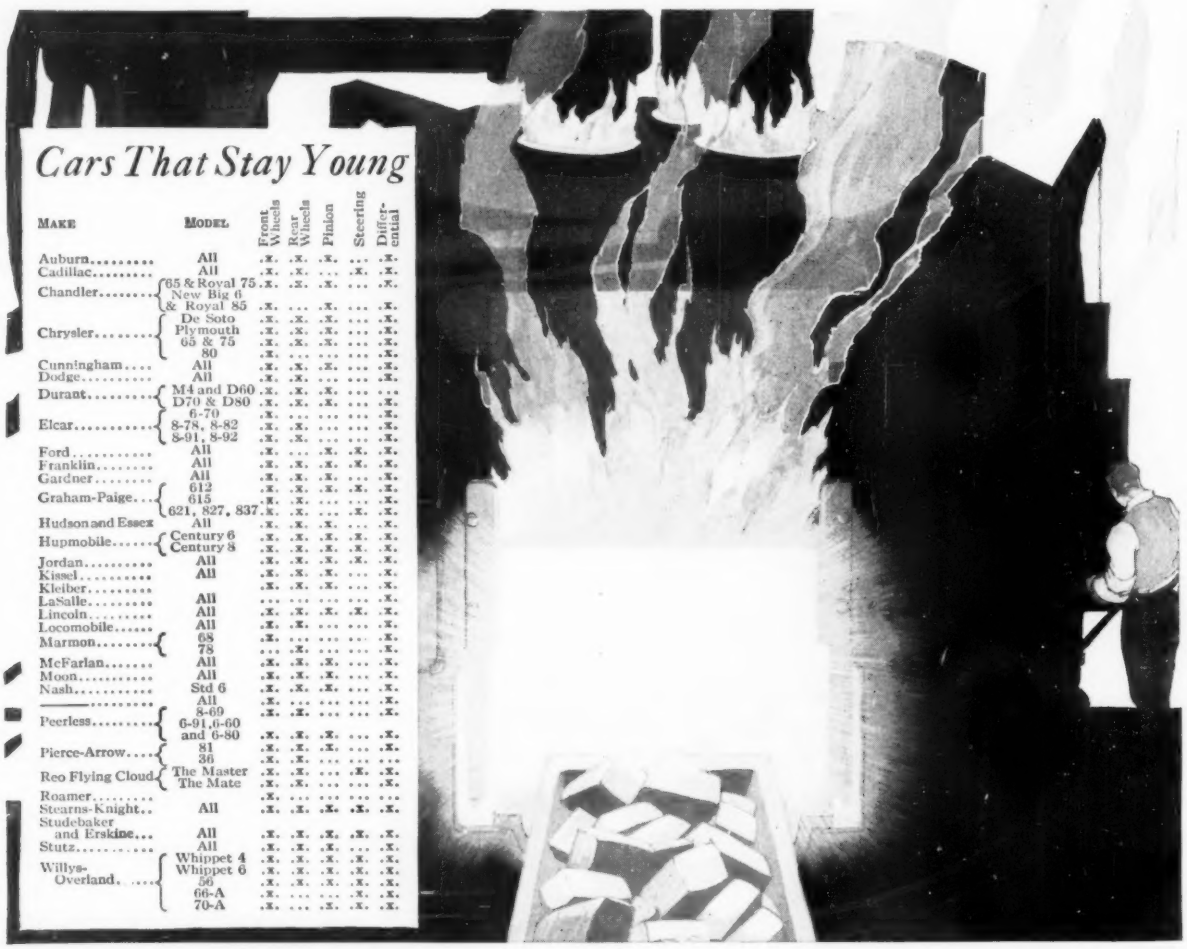
TIMKEN PROTECTION GOES FURTHER—Timken tapered construction and Timken *POSITIVELY ALIGNED ROLLS* reduce friction; capably cope with thrust, shock and speed; and defy wear as miles and years go by.

To know these Timken advantages is worth while—to *get* them is worth money.

"Timken-Equipped" sums up the situation. It is a phrase alert engineers remember, live dealers stress and keen buyers use as a guide.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO



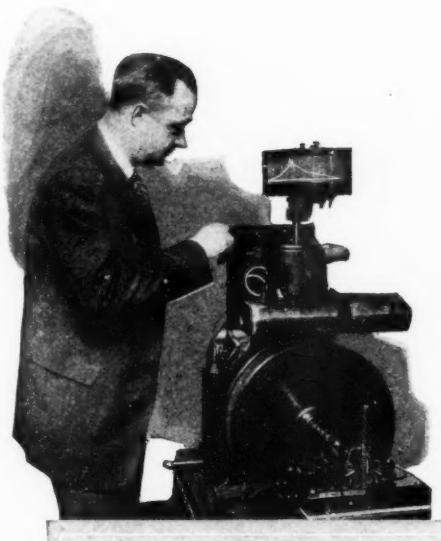


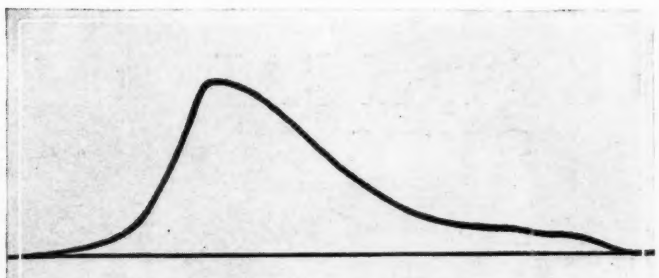
Cars That Stay Young

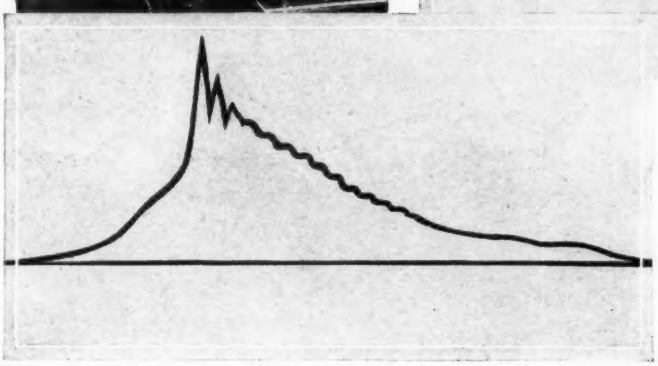
MAKE	MODEL	Front Wheels	Rear Wheels	Pinion	Steering	Differential
Auburn	All	X	X	X	...	X
Cadillac	All	X	X	...	X	X
Chandler	65 & Royal 75	X	X	X	...	X
	New Big 6 & Royal 85	X	...	X	...	X
Chrysler	De Soto	X	X	X	...	X
	Plymouth	X	X	X	...	X
	65 & 75	X	X	X	...	X
	80	X	...	...	...	X
Cunningham	All	X	X	X	...	X
Dodge	All	X	X	...	...	X
Durant	M4 and D60	X	X	X	...	...
	D70 & D80	X	X	X	...	X
Elcar	6-70	X	...	...	...	X
	8-78, 8-82	X	X	...	...	X
	8-91, 8-92	X	X	...	...	X
Ford	All	X	...	X	X	X
Franklin	All	X	X	X	X	X
Gardner	All	X	X	X	...	X
Graham-Paige	612	X	X	X	X	X
	615	X	X	...	...	X
	621, 827, 837	X	X	...	X	X
Hudson and Essex	All	X	X	X	...	X
Hupmobile	Century 6	X	X	X	X	X
	Century 8	X	X	X	X	X
Jordan	All	X	X	X	X	X
Kissel	All	X	X	X	...	X
Kleiber		X	X	X	...	X
LaSalle	All	...	...	...	...	X
Lincoln	All	X	X	...	X	X
Locomobile	All	X	X	...	...	X
Marmon	68	X	...	...	...	X
	78	...	X	...	...	X
McFarlan	All	X	X	X	...	X
Moon	All	X	X	X	...	X
Nash	Std 6	X	X	X	...	X
———	All	X	...	...	...	X
Peerless	8-69	X	X	...	...	X
	6-91, 6-60 and 6-80	X	X	X	...	X
Pierce-Arrow	81	X	X	X	...	X
	36	X	X	...	...	...
Reo Flying Cloud	The Master	X	X	...	X	X
	The Mate	X	X	...	...	X
Roamer		X	...	...	...	...
Stearns-Knight	All	X	X	X	X	X
Studebaker and Erskine	All	X	X	X	X	X
Stutz	All	X	X	X	...	X
Willys-Overland	Whippet 4	X	X	X	X	X
	Whippet 6	X	X	X	X	X
	56	X	X	X	X	X
	66-A	X	...	...	X	X
	70-A	X	...	X	X	X

TIMKEN *Tapered Roller* BEARINGS

Did you ever see a picture of a "KNOCK"?







This is what happens in the cylinders of a gasoline engine when it is running smoothly. The pressure gradually increases after ignition until the mixture is nearly all burned. Then it grows less and less.

But when the gasoline is causing the engine to knock, just see what happens. Is it any wonder that the engine loses power? Ethyl Gasoline prevents that jagged saw-tooth.

© G. M. C. 1929

THAT sounds peculiar, doesn't it? Yet we can get a perfectly good picture of the "knock" in a gasoline engine. Those two curious looking diagrams were taken with a Midgley Indicator and show the pressures inside the cylinder of a gasoline engine.

The one on the right is the pressure diagram of a normally operating engine, while the one on the left shows a "knocking" engine. So the "knock" really is the part of the diagram that looks like saw teeth.

These little diagrams were most important. Through them, the scientists in the General Motors Research Laboratories discovered that it was the *fuel* that "knocked"—not the engine. This fact established, they developed Ethyl Gasoline, whose active anti-knock ingredient is tetraethyl lead.

The end of the long research resulted in Ethyl Gasoline's being put on the market by leading oil companies. It encouraged automobile manufacturers to bring out the present high compression engines and to give the motoring public a new kind of motoring comfort and efficiency. It is called *high compression performance.*

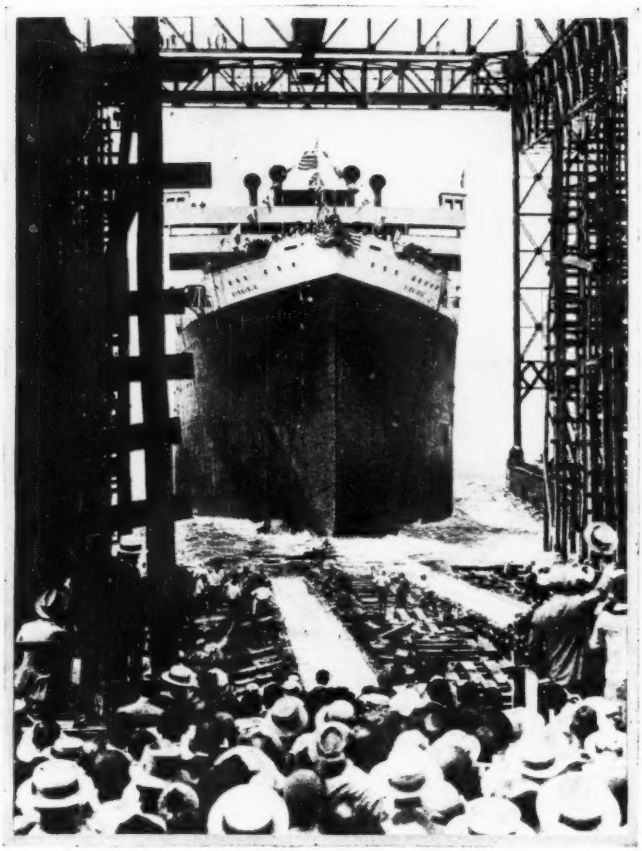
The millions of cars of ordinary compression run better on Ethyl too—for by the elimination of "knock" they develop more power and flexibility.

Ride with Ethyl today.

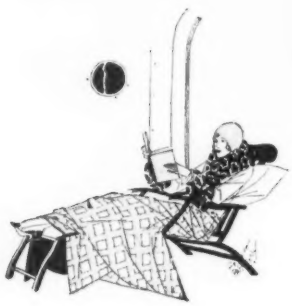
ETHYL GASOLINE CORPORATION—25 Broadway, N. Y.
56 Church St., Toronto, Canada—36 Queen Anne's Gate, London, England

ETHYL GASOLINE

Knocks out that "knock"



Another ELECTRICAL CITY *moves out to sea*



THE launching of the Electric Ship *Virginia*, sister ship of the *California*, adds one more great liner to the growing fleet of all electric passenger vessels. The *Virginia* and *California* are now in service on the Panama-Pacific Line of the International Mercantile Marine.

These ships are driven by electric motors; lighted, heated, and cooled by electricity; electricity mans the winches, bakes the bread, polishes the silver—surrounds the passengers with every luxury of a modern hotel.

Vibrationless beyond belief—both the *Virginia* and the *California* are delighting their passengers with a new revelation of sea-going comfort.

This monogram appears on the huge motors which drive the S.S. *Virginia*—at a remarkably low fuel cost—less, in fact, than the canal tolls. In homes and factories, as well as on ships, the G-E monogram identifies the accepted standard of electrical dependability.

GENERAL ELECTRIC

95-629

SCIENTIFIC AMERICAN

24 WEST 40th STREET — NEW YORK CITY

March 1929 — *Edited by ORSON D. MUNN* — *Eighty-fifth Year*

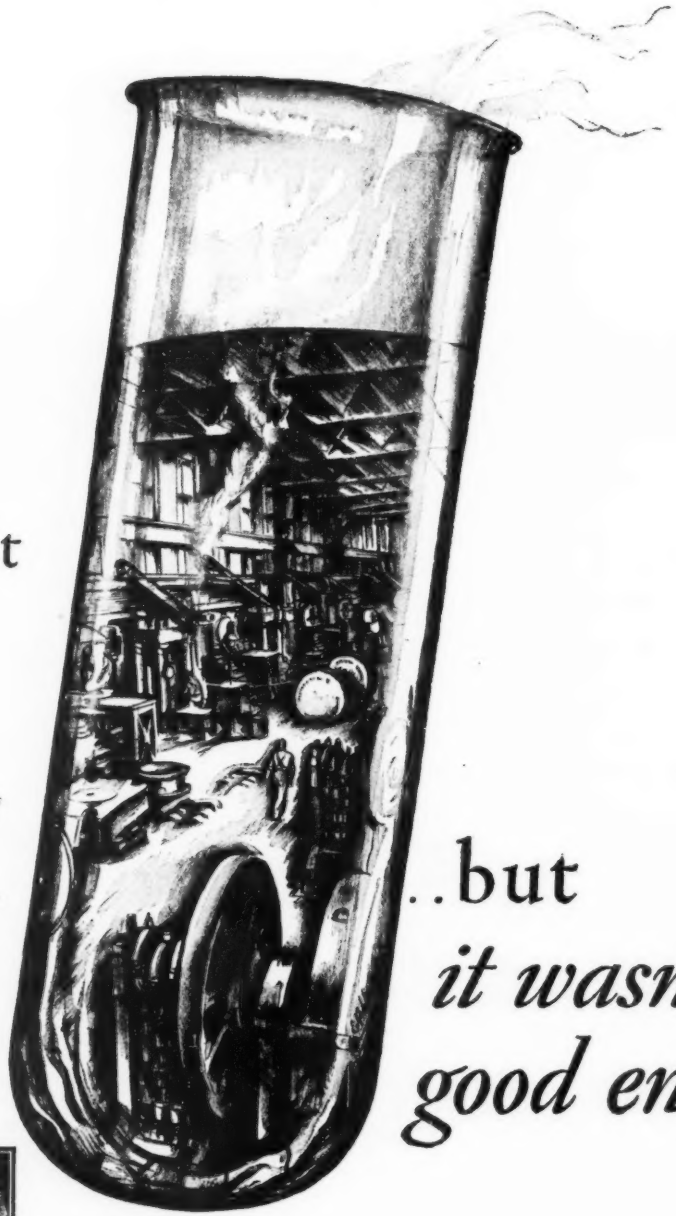
IN THIS ISSUE

CONTENTS—MARCH, 1929

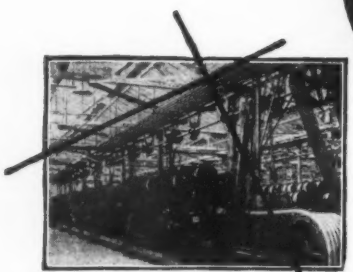
COVER

One of the main features of this, our Special Aviation Issue, is the article entitled "Planes for Private Flying," starting on page 206. Among the planes discussed at some length is the Loening amphibian, and one of these ships of the air, capable of operating from land or water, is illustrated in its standard colors on our cover.

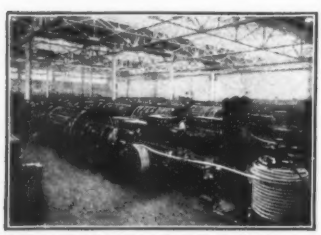
The best cable shop in the country . . .



. . . but *it wasn't good enough*



The old way. This machine for stranding cable was the best in the country, but—



Western Electric engineers worked out a new way, stranding cable more quickly, more safely, more economically.

IN equipment and methods the Western Electric telephone cable plant of 1927 set the pace. But that didn't satisfy the company's manufacturing engineers. They put the plant in the test tube of critical judgment—and they came out with something even better.

It meant revising processes, redesigning machines, rebuilding a factory which occupied sixteen huge structures. But it was worth it!

Whether making cable or any of the 10,000 items of telephone apparatus, Western Electric seeks till it finds the better and more efficient and more economical way. As manufacturer for the Bell System this is its share in good telephone service.

Western Electric

MAKERS OF YOUR TELEPHONE

Scientific American, March, 1929, Vol. 140, No. 3, entered at the New York, N. Y., Post Office as Second Class Matter June 28th, 1879, under the Act of March 3rd, 1879; additional entry at Dunellen, N. J. Published Monthly by Scientific American Publishing Co., 24 West 40th Street, New York City. Copyright 1929 by Scientific American Publishing Co. Great Britain Rights Reserved. Subscription Price $4.00 per year.

Looking Ahead *With the* Editor

For or Against Health Ray Glass

SO much doubt, uncertainty—even misinformation—has been current concerning the value of special health ray transmitting glass that the Editor appealed to a score of America's most noted authorities on ultra-violet radiation—physicians and physicists—for their unbiased opinions. These will be available in exhaustive form in our next issue. This complete report is expected to exert a marked influence on the value the public sets on special ultra-violet transmitting glass.

An Epic of Construction in the Jungle

"SENOR, it can't be done!" said the wise ones. But George A. Kerr, American and fearless, did it. In the jungles of Paraguay he built the world's largest quebracho extract plant. He taught wild Indians and pirates how to work; he built a dock, a carpenter shop, a brass and iron foundry; made 7,000,000 bricks; and built a 60-mile railway. You will thrill with the romantic story of his adventurous job as told in our pages soon.

Solar Research for Amateurs

THE discoveries of amateurs constitute the most inspiring chapters in the story of science, according to Dr. Hale of Mt. Wilson Observatory, in an article now ready for release. He tells of the spectacular, ever-changing phenomena of the sun and the fantastic beauty of solar prominences. He then shows how the amateur telescope maker can revel in the wonders of this fascinating study with the new spectrohelioscope.

Temples of Astaroth

IN Bible and ancient history and in present-day archeology, Beth-shan, battle-scarred town of antiquity, is pregnant with interest. When King Saul was killed in battle by the Philistines, his body was fastened on its walls, according to the Bible. Excavations of this site—the Scythopolis of the Greeks—have revealed traces of its many different occupants and shed new light on ancient history, as brought out in a coming article.

Food Made To Order

FOOD made synthetically from wood is just one of the products resulting from the many years' research in Germany into the secrets of coal and wood. Dr. Bergius, famed German scientist who has been intimately connected with this work, has written an article for us telling how they made artificial coal from wood, gasoline from coal, and food from either. Their researches indicate many new uses for coal and wood.

Every Issue Fully Illustrated

¶ *The well-informed man or woman is the one who progresses. Why not let the* SCIENTIFIC AMERICAN *bring to you the latest news of the scientific world in general? The cost is nominal—only four dollars for an entire year's subscription.*

Among Our Contributors

Alexander Klemin

One has but to meet Professor Klemin and note his dynamic personality to understand how he can divide his time among so many interests. His position as professor in charge of the Daniel Guggenheim School of Aeronautics at New York University and his affiliation with many aviation projects enables him to keep his hand on the pulse of aviation better, perhaps, than any other man in this country. He is also a corresponding editor of this magazine, and contributes a monthly department.

C. E. Rosendahl

Lieutenant Commander Rosendahl, a Naval Academy graduate in 1914, volunteered for airship duty in 1923 and received airship training at Lakehurst. He was the senior survivor of the disaster which overtook the *Shenandoah* in 1925. He was then ordered to the *U. S. S. Los Angeles* and, in May, 1926, was given command of this ship, a commission which he still holds. He was the United States' naval observer on the trial flights of the huge German dirigible, the *Graf Zeppelin*.

William Bowie

Dr. Bowie has had charge of the Division of Geodesy at the United States Coast and Geodetic Survey since the year 1909. Geodesy underlies all refined map making. He has also had much to do with the establishment of the widely accepted theory of isostasy—balance between sinking and rising areas of the earth's surface. Thus his work pertains both to engineering and pure science. He is President of the Geodetic Section, International Geodetic and Geophysical Union.

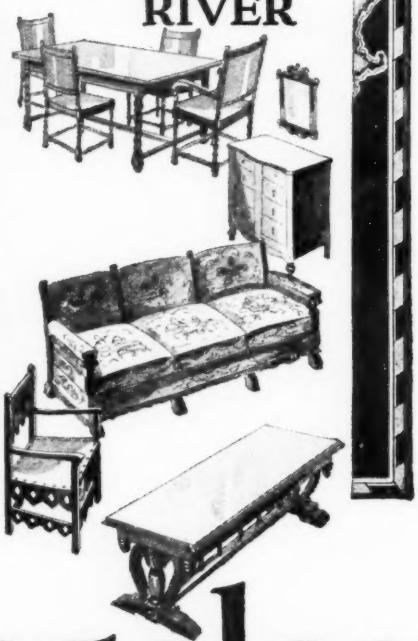
Edmund James

In his article on page 222, Mr. James has shown what an amateur aviator can do once he makes up his mind to fly. In the same manner that his work in building a glider was inspired by an article in these pages, others may be inspired by his detailed story.

FIRST

in Production of FURNITURE

West of the MISSISSIPPI RIVER



Los Angeles

THE INDUSTRIAL COUNTY

HOMES make the Nation's industries. Furniture sales mean substantial home buyers. Not only is the immense concentrated market of Southern California responsible for western leadership of Los Angeles furniture manufacturers but quick and economical distribution brings the vast Western States market to them. The same elements that have given western predominance to furniture manufacturers in Los Angeles County, can and will bring development to manufacturers in other lines.

New manufacturers will find these advantages in Los Angeles County:—Good factory sites—Low building costs—Contented open-shop labor—Mild climate—Largest concentrated market on Pacific Coast—Cheap varied raw materials—Strategic location for export—and low power costs.

For more specific information kindly address

INDUSTRIAL DEPARTMENT LOS ANGELES Chamber of Commerce

INDUSTRIAL LOS ANGELES COUNTY

Commander Richard E. Byrd, U. S. N. (Ret.)

FEW of those who are following the news of "Dick" Byrd's antarctic expedition are aware of the extent of his polar experience. Before the war he flew in sub-arctic regions with a governmental airplane survey in icy Newfoundland. He is such an expert navigator that when he flew to the North Pole and return in 1926, the perfect plotting of his course both ways elicited the praise of experts all over the world. After his almost disastrous non-stop transatlantic flight in 1927, he immediately began preparations for his present expedition and got together the most complete outfit of its kind in the history of polar exploration. He expects to solve many secrets of the Antarctic continent in airplane flights covering a period of perhaps two years. His expedition is now at its base.

Sailing Serenely After a Stormy Trip

THE German *Graf Zeppelin*, present holder of the world's record for size, as she appeared from one of the welcoming airplanes while over Perth Amboy, New Jersey, on her way to New York City after her successful trip over the Atlantic in October, 1928. Over a hundred hours previously, she had taken off from Friedrichshafen, Germany, where she had been constructed, had headed for the United States by way of the Azores and Bermuda, had been thrown off her course by storms and wind, and had sustained severe damage to one elevator. On her arrival, she flew over Washington, Philadelphia, and New York, and then proceeded to Lakehurst where she berthed. Her return trip to Friedrichshafen required slightly over 71 hours.

NOSING DOWN TO A LANDING

The *Graf Zeppelin*, greatest dirigible in the world at this time, preparing to make a landing at Friedrichshafen, Germany, after one of its trial flights. The hangar farthest to the left is the one used during construction of the ship

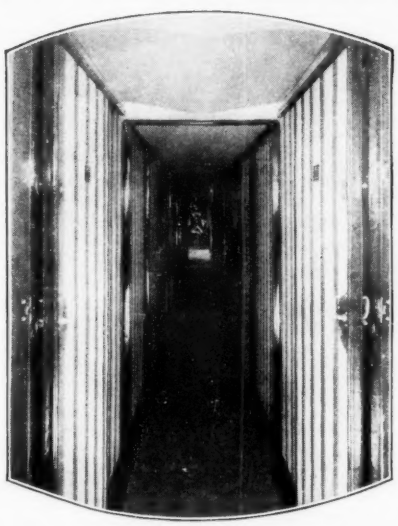
Inside the "Graf Zeppelin"

The United States' Official Observer on the Monster Dirigible's Flight to America, Tells the Details of Its Construction

BY C. E. ROSENDAHL
Lieutenant Commander, United States Navy

FOR the moment, the German rigid airship *LZ-127*, named after that most famous exponent of airships, Count Zeppelin, is the largest aircraft in the world. Although not privileged to enjoy this distinction very long because of the promised early advent of British and, a little later on, our American naval airships, the *Graf Zeppelin* is approximately half again as large as its immediate predecessor, the *Los Angeles* of 2,600,000 cubic feet gas volume, and contains certain innovations. Because of these new features as well as because of her recent historical round trip between inland Germany and the United States, the characteristics of this ship demand attention.

It is generally known that modern design tendency is toward the comparatively shorter and fatter type of airship, or toward a smaller "fineness ratio." In this respect, however, the *Graf Zeppelin* is of the previous conventional Zeppelin style rather than of the well-recognized breed of the smaller fineness ratio. Faced with the mission of constructing a ship of an advanced performance and having no choice of suitable building sheds, it became necessary to design the largest ship possible of erection in, and operation from, one shed at Friedrichshafen; therefore the characteristics of the *Graf Zeppelin* were almost automatically determined by the dimensions of this shed. The Luftschiffbau Zeppelin can therefore be said to have done very well in producing so successful a ship in spite of certain fundamental initial difficulties.

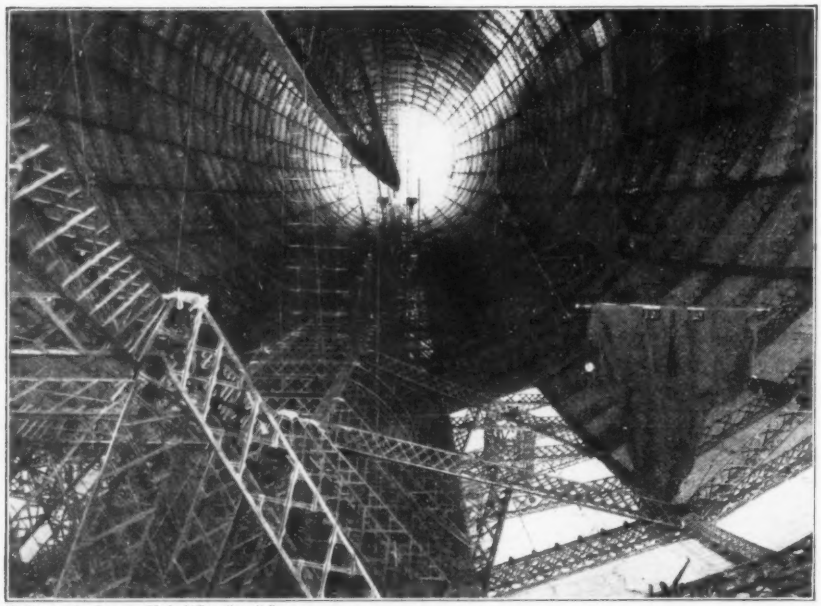


THE CENTRAL CORRIDOR

Looking aft down the corridor in the cabin space. Cabin doors on each side

A glance at the main dimensions and characteristics of this ship is desirable at this point:

Length	770.995 feet
Maximum diameter	100.06 feet
Fineness ratio	7.7 to 1
Overall length	776.408 feet
Maximum height—Axis horizontal and on forward buffer bag	110.788 feet
Maximum height—Ship on both forward and after buffer bags	113.024 feet
Nominal gas volume (95 per cent fulness)	3,708,000 cubic feet
Maximum possible volume	



All Photographs Courtesy "Luftschiffbau Zeppelin"

INTERIOR VIEW OF THE NEW ZEPPELIN, WITHOUT CELLS

What appears to be a jumble of girders, struts, and wires: the *Graf Zeppelin's* interior before installation of gas cells. Main frame wiring, keel passage, and upper corridor are visible

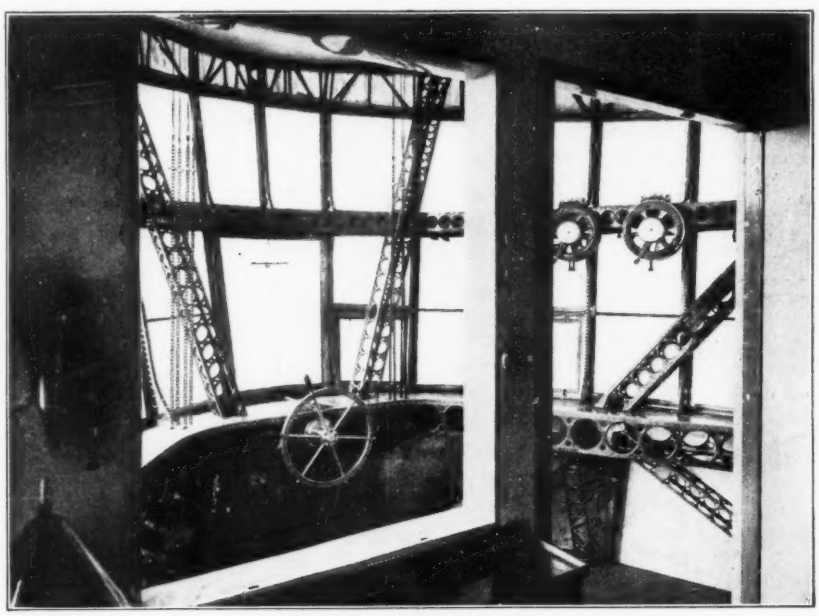
of lifting gas cells about..... 3,178,000 cubic feet
Normal inflation volume of lifting gas cells about..... 2,295,000 cubic feet
Maximum capacity of fuel gas cells about.... 1,482,000 cubic feet
Number of lifting gas cells..... 17
Number of fuel gas cells..... 12

The motive power consists of five wooden "pusher" propellers each driven by a V-tvpe Maybach motor. These units are contained in five separate exterior power cars suspended from the hull of the ship in the conventional manner—that is, two pairs of wing cars and one after centerline car, or identical with the *Los Angeles'* arrangement. Power cars are so placed as to minimize air flow interference.

THE type of Maybach motor—the VL-2—used in the *Graf Zeppelin* is fundamentally the same as that in the *Los Angeles* except for certain recent refinements and advances such as an increase in the compression ratio and in the revolutions per minute which result in increased horsepower over the VL-1. The principal characteristics of this motor are:

Number of cylinders..... 12
Cylinder bore..... 5.510 inches
Stroke..... 7.086 inches
Cylinder volume. 2025.00 cubic inches
Compression ratio.....7 to 1
Rated horsepower at 1312 feet above sea level..... 550
Revolutions per minute at above horsepower..... 1600
Fuel consumption per hour per motor at 1600 revolutions per minute—about..... 257.940 pounds
Oil consumption per hour per motor at 1600 revolutions per minute—about.....5.51 pounds
Cruising speed, revolutions per minute.....1450 to 1500
Horsepower developed at cruising speed.....450
Fuel consumption per motor per hour at cruising speed..... 202.825 pounds
Weight of each motor..... 2535.3 pounds (including fly wheel, air compressor, starter, et cetera.)
Length of motor.....6.397 feet
Height of motor.....3.18 feet
Width of motor.....3.05 feet

The structure of the ship follows, of course, the conventional incorporation of main and intermediate rings or tranverse members, and main and intermediate longitudinals. Main rings are stiffened by wire bracing and are spaced 49.2 feet apart. Intermediate frames or rings occur every 16.4 feet. The cross-sectional shape is that of a 27-sided polygon. A main longitudinal corridor of triangular cross-section, running the length of the ship along the bottom, provides the usual access throughout the ship and has branching corridors leading to the wing power-cars. Necessitated by the use of a gaseous fuel, there has been incorporated another longitudinal corridor or gangway located at about two fifths of the diameter up, or where the lift-gas cells and the fuel-gas cells would normally meet, when inflated, and extending for the length of the 12 fuel-gas cells. Several vertical trunks are provided for communication and passage between the two longitudinal corridors. The usual ventilation trunks to the top of the ship



THE "BRIDGE"

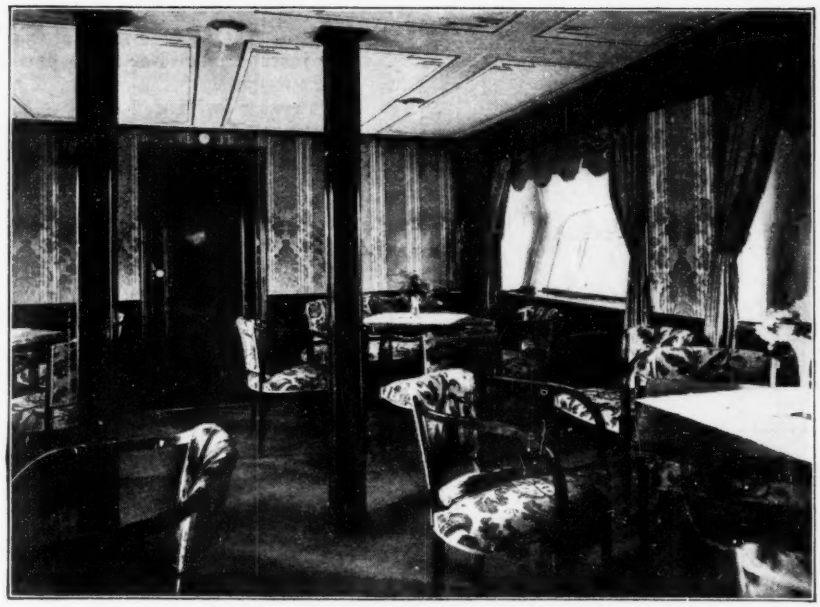
View from the port side of the navigator's room into the control space. The rudderman's wheel and the engine telegraphs—on window frames at the right—are clearly shown here

are installed in the conventional manner.

In general, triangular girders, either double or treble latticed, are used throughout. The duralumin employed in the structure of the *Graf Zeppelin* is an improvement over previous grades of this material and is said to be 20 percent stronger for the same weight than similar structural metal used in the *Los Angeles*.

THE gas cells are located in the compartments formed by the main rings and lined with a ramie cord netting. The lifting-gas cells occupy the upper portion of these spaces whereas 12 of the lower spaces contain fuel-gas cells. Three spaces at one end and two at the other contain only lift-gas cells. In the compartments containing both types of cells, the upper or lift cells are of such size that under normal operating conditions they are never full. All lift-gas cells are equipped with automatic valves to relieve possible excess pressure; certain of them are equipped also with maneuvering valves operated from the control car. None of the fuel-gas cells have automatic valves as they are built of a size considerably greater than their normal fulness and in case of excess expansion and consequent interior pressure, the release of lifting gas through the automatic valves of the lift cells above would compensate. Some of the fuel-gas cells are equipped with hand-operated valves. The material of both lift and fuel cells is the same; it is a cotton fabric lined with two layers of goldbeater's skins and varnished and aluminized on both sides.

The stabilizing and control surfaces are four each of the usual streamlined types located at the stern. The upper vertical and the two horizontal fixed surfaces are each 1722 square feet in area. The lower vertical fin is 1302.4 square feet. The lower rudder is of 215.28 square feet, whereas the upper rudder and the two elevators (or horizontal rudders) are each of 269 square feet area.



LIKE A LUXURIOUS SHIP'S LOUNGE

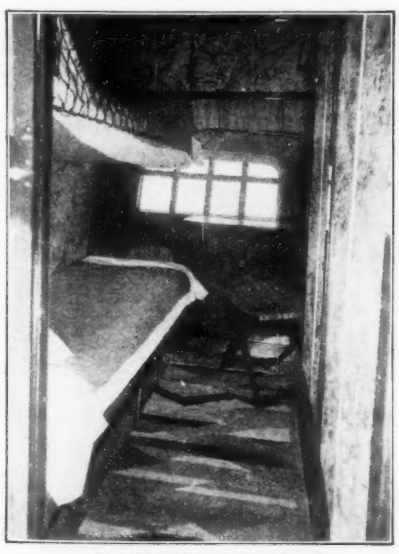
The dining salon of the *Graf Zeppelin*, looking aft. The door shown leads out into the cabin space. This very attractive room is amply large to be used as a lounge for 24 persons

HAND power steering of the satisfactory type of the past is employed and functions easily and freely, although in larger ships the use of servo-motors may prove desirable or necessary. The rudders and elevators can be operated throughout an arc of 20 degrees on either side of neutral. The elevators are of the balanced type whereas the rudders are unbalanced.

The outer cover is an especially strong light cotton fabric stretched and laced on in longitudinal panels with the edges overlapped by sealing strips. This cover is treated with "dope" and aluminized after being laced in place. The whole surface is then sand-papered to give as smooth a finish as possible. Certain portions of the bow and stern and the control and stabilizer surfaces are covered with a slightly heavier and stronger fabric.

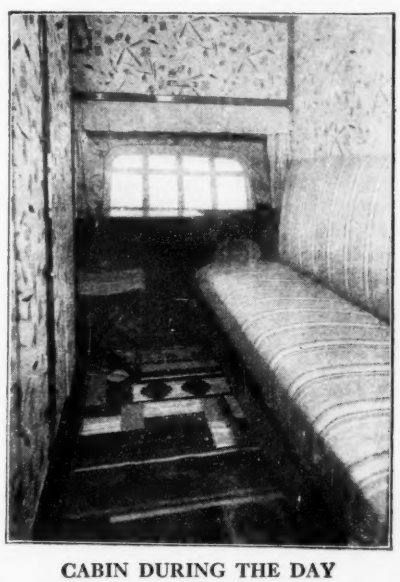
The forward car, which includes within it the control room (bridge), navigator's and radio rooms, kitchen, dining salon, cabins, and other passenger accommodations, is an integral streamlined part of the structure located well forward so as not to add cross-sectional area or height to the ship. The steering room, or bridge proper, is located in the extreme forward end of the car where the best vision is possible. Immediately adjoining it is the navigator's work room extending across the width of the car. This can be cut off by light-proof screens. Then come the kitchen to starboard and the radio room to port. Next is the spacious dining salon and the passenger cabins, washrooms, and toilets. Access from the hull into the forward car is provided by a ladder from the keel passageway into the navigator's room and by a staircase from the after end of the car into the keel.

In the control or steering room we find the rudderman's stand, the elevatorman's stand, the engine telegraphs, and miscellaneous controls and instruments. Wheels similar to those of surface ships move the steering surface aft through sprockets, chains, and control wires along the keel.



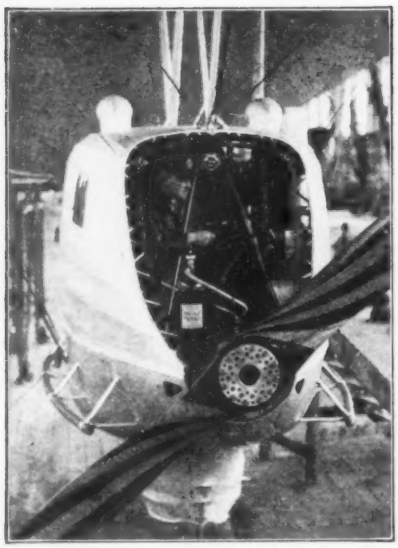
READY FOR SLEEPING

Sleeping cabin made up for the night. Ventilator control is above window



CABIN DURING THE DAY

One of the cabins made up for day use. Clothing closets are opposite the couch



THE AFTER POWER CAR

Engine car partially open to show working space. Note handling rails

The rudderman's stand is equipped with a ship's magnetic compass, rudder position indicators, and a windshield wiper for clearing vision ahead. Because of the absence of steel and other deviation inducing materials from the vicinity of the compass, no compensating binnacle is necessary. A readily operated clutch allows the rudderman to disconnect the upper or lower rudder should either be damaged; ordinarily they are operated together.

At the elevatorman's stand which is on the port side we find: two inclinometers; a statoscope; a variometer; an altimeter; thermometers for air, fuel gas, and lifting gas; a gas-pressure alarm of new and clever design; two elevator indicators and a clutch similar to the rudderman's; and a stop watch. Just above and near the elevatorman is located the control box providing the toggles for ballast and gas control.

ON the starboard side at the captain's stand are the engine telegraphs to each power car, an airspeed meter, and a variometer. In the navigator's room, in addition to the chart table and stowage for charts, books, and instruments are provided: a fluid compass, an altimeter, a barograph, an aerograph, an airspeed meter, drift and ground speed meters, a recording thermometer for air, gas, and fuel temperatures, and the usual astronomical navigational instruments and accessories common to any ship. Interior communication is provided by voice tubes to certain locations and by a telephone in the navigator's room connected to five other stations throughout the ship.

Electrical power is used for lighting purposes, cooking, heating water, radio, and telephone. The principal power sources are three wind-driven generators and a 100 ampere-hour storage battery installation. For radio power a constant-speed, wind-driven, 600-watt generator is located on the port side of the radio room. An emergency radio motor-generator, driven by the lighting batteries, is available for short emergency use. Also, a small gasoline-driven generator is located under the floor of the navigator's room. It is interesting to note that this generator was used during periods of low airspeed after the stabilizer damage on the trip to the United States. A wind-driven cooking generator is installed outboard of the kitchen on the starboard side. Another such generator of 1.5 kilowatts power is located at the after end of the passenger car for charging the battery installation, et cetera. Additional electrical equipment is a portable signal searchlight, a motor for the radio antenna reel, and a radio-battery charger. All switches are of the enclosed, safety type.

The radio equipment consists of a main transmitter of 120 watts power operating on wavelengths of 575 to 2300 meters; an auxiliary 70-watt transmitter including wavelengths from 300 to 1800 meters; and three receivers for wavelengths between 300 to 4000 meters. The suspended two wire antenna may be reeled in by power or by hand. A radio compass for use on wavelengths of 400 to 4000 meters is provided, the compass coil being located in the buffer bag of the forward car. Short-wave radio equipment is contemplated and provided for. Three radio operators are carried and a continuous watch is stood.

THE passengers' dining salon, 16.4 feet square, affords much comfort also as a lounging room for 20 to 24 persons. Tables, chairs, and settees are provided in abundance and the large windows on each side—some sliding open—provide a splendid protected view during flight. The walls and ceilings of the salon and the cabins are covered with fancy cloth, each cabin finished in a different design. All passenger spaces are ventilated. At the present they are not heated but such an installation can be provided readily.

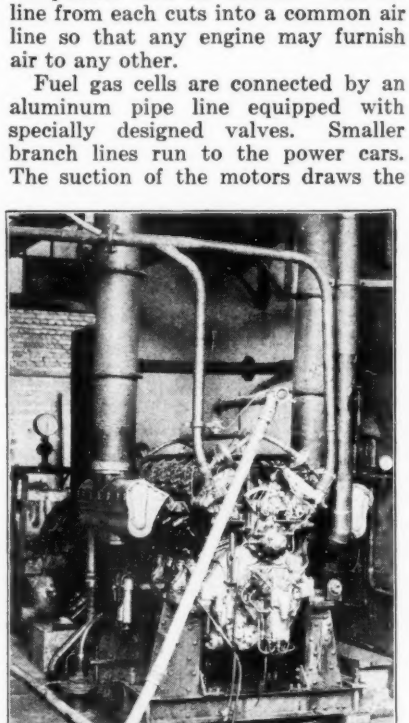
The sleeping cabins are located on each side of a central corridor abaft the dining room. There are 10 separate two-berth cabins each equipped with clothes closets, a table, a collapsible chair, an outboard window, and electric lights. Abaft these in a compartment cut off by doors are found two washrooms, toilets, and a storeroom. Each washroom contains two washbowls, mirrors, et cetera; hot and cold water is supplied from the faucets. Special racks for baggage other than hand luggage and for freight are located in 34 spaces along the keel passageway. Noise from the engines, which are well aft, does not disturb the passengers at all.

The quarters for the ship's officers and crew are located up within the hull proper along the keel passageway. The captain has his own stateroom; three other staterooms equipped with tables and seats are provided. Sleeping berths for the crew, shielded from the draft, are located along the keel. Excellent ventilation is had to rid the ship of any gas which might leak through the cells. Automatic ventilating hatches and an exhausting hood are installed for this purpose.

BENZINE, the secondary fuel used in the *Graf Zeppelin*, is carried in seven groups of three aluminum tanks each. These hold 110 gallons each.

Enough benzine is carried ordinarily to offset the lift of the largest gas cell in case of deflation, as the fuel tanks are so suspended that they may be readily dropped from the ship. Provision for additional fuel tanks is made at a number of locations. All tanks are connected to a common fuel main. Wind-driven pumps are available for transferring fuel for trimming purposes and for sending fuel to the service tanks near each power car from which the engines are fed by gravity. Lubricating-oil tanks are provided at convenient locations in the keel. The motors are started and reversed by compressed air, each having its own compressor and air bottles. The air line from each cuts into a common air line so that any engine may furnish air to any other.

Fuel gas cells are connected by an aluminum pipe line equipped with specially designed valves. Smaller branch lines run to the power cars. The suction of the motors draws the



TESTING AN ENGINE

One of the dirigible's Maybach engines being tested before its installation

fuel gas from the cells and engines may be fed from any cell or combination.

Some of the *Graf Zeppelin's* improvements over past airships have already been indicated, but the principal advance is represented in the adoption of a gaseous fuel.

One reason for the adoption of a fuel of this type is that a greater number of heat units can be carried and an increase in cruising radius of 20 to 25 percent becomes possible over that which can be obtained with a hydrogen-gasoline ship.

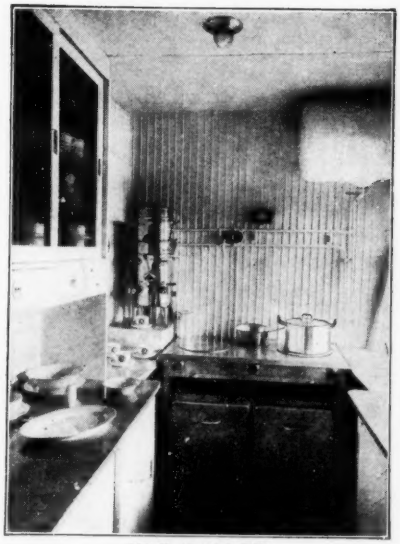
Secondly, there is a reduction in the stresses in the structure of the airship due to the absence of heavy fuel loads. It is easy to visualize the stresses that can be set up in the structure by a heavy fuel load when the ship is subjected to the currents and instability of squalls or storms. The main advantage, however, lies in the non-disturbance of the static relation between load and lift due to the consumption of a fuel of the same density as air.

WHILE the introduction of gaseous fuel as an operating feasibility is a novel departure from past practice, it is not an entirely new idea. It has often been proposed that hydrogen inflated airships might increase their range by burning excess lifting gas as fuel but this was practicable only to a small extent. The use of coal gas as an inflation medium and as a fuel as well was also suggested years ago but the use of Blaugas was first put into practice in the *Graf Zeppelin*.

As may be generally known, when an airship (or any balloon) takes off, ballast is adjusted to make the lift or buoyancy predominate slightly over the load so that the craft rises statically into the air. As the loads within the ship are consumed—which in the ordinary ship are principally the fuel—the lift would, unless compensated for, soon predominate to a point where a considerable portion of the dynamic power of the ship would have to be used to overcome the excess buoyancy and maintain the flight at the desired altitude. Of course, it is possible to reduce this excess buoyancy by valving or releasing a portion of the lifting medium. In the case of a hydrogen-inflated ship, while costing something appreciable, it is nevertheless practicable. In a ship inflated with helium, such operation might prove more expensive. In our American helium-inflated airships, however, the expenditure of fuel is compensated for by the condensation and collection of the water of combustion from the engines and the occasions on which valving must be resorted to are very rare. The adoption of Blaugas, however, solves, in a different manner, the matter of maintaining the static equilibrium of the ship.

BLAUGAS, named after the German chemist, Doctor Blau, who first invented the manufacturing process, is a hydrocarbon gas produced from crude oil. Its density is approximately that of air—actually about 1.05. It is stored in the ship as previously indicated in fabric gas-cells and is, therefore, always at atmospheric pressure. As Blaugas is consumed—since it is of the same density as air, or approximately so—there is no reduction in the load of the ship because of the consumption of fuel. The shift from gaseous fuel to benzine, or vice versa, is easily accomplished, as the Maybach engines are equipped with a simple mixing valve which permits this change readily.

One of the difficulties in the employment of a gaseous fuel is that of obtaining and transporting it. Difficulty is still being experienced in Germany with the production of Blaugas from crude oil on a quantity basis. In the United States we are more fortunate, however, in that our natural gas sources in many localities provide gases suitable for mixing to form a fuel of the required density, calorific value, and other properties. The greatest item of expense and trouble lies in the fact that this gas must be compressed into liquid form and shipped under pressure. It is readily apparent therefore that there are difficulties and expense involved in placing a gaseous fuel at the points where a few airships might require it. Furthermore, in the United States, we have a great abundance of helium for use as the inflation medium of airships and it is still a point for argument whether anything in safety to our ships would be gained by the introduction of a gaseous fuel. The maximum safety from this standpoint will be achieved when airships combine the use of helium as the inflation medium and heavy-oil engines as their propulsion plants.

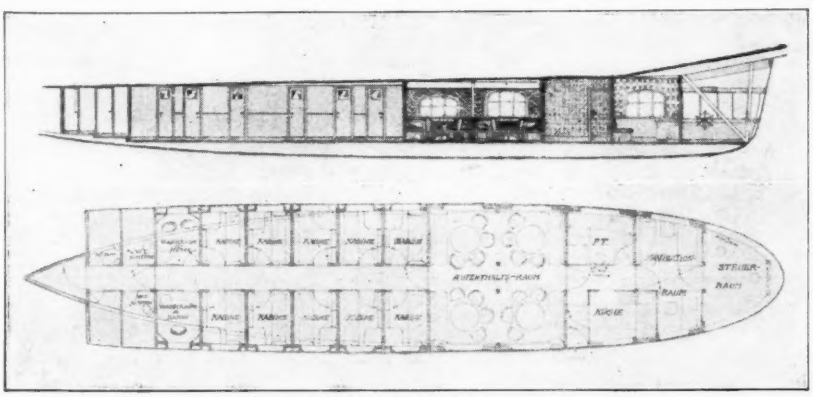


THE GALLEY

The kitchen of the new dirigible is electrical. Note orderly arrangement

THE maximum speed of the *Graf Zeppelin* is slightly less than 80 miles per hour, but it is expected that this will be brought up to 80 or over. The cruising speed of the ship is 70 miles per hour. After her historical first crossing of the Atlantic covering a distance of 6000 miles—the time having been drawn out to 112 hours because of a damaged stabilizer enroute—there still remained a 65 hours' fuel supply.

While the *Graf Zeppelin* is probably the strongest airship yet built, the regular commercial conquest of the North Atlantic will undoubtedly be made by even stronger and larger ships. While this region is, no doubt, one of the most lucrative in the realm of transportation, it is, nevertheless, one of the most difficult for the operation of any type of carrier, as steamship operators realize each winter. There are many fields of fruitful endeavor open to the *Graf Zeppelin* and without a doubt this ship will prove an important milestone in the development of the ultimate universally useful rigid airship.



CONTROL AND PASSENGER CAR

From bow to stern, the rooms are as follows: The steering room: navigation room; kitchen; dining room; 10 passenger cabins; washrooms—one for men and one for women; and toilets

AN UP-TO-DATE AIRPORT

A vital part of flying is the provision of suitable landing fields and adequate servicing facilities. Fields of this type give great impetus to private flying by providing safe and convenient centers for flying activities

Courtesy Curtiss Aeroplane and Motor Company

Planes for Private Flying

A Comprehensive Survey of the Aviation Field, as it Concerns the Individual Who Desires to Purchase a Plane for Personal Use

By Prof. ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University
Corresponding Editor, SCIENTIFIC AMERICAN

MILLIONS of people in the United States are deeply interested in flying and hundreds of thousands have already taken short or long flights. To have flown once generally means to wish to fly again. The air seems to offer a refuge from crowds, from roads congested with automobiles, and to give the ultimate in freedom of motion. To many young men, the ownership of a plane is a fascinating thought. The sky will not be darkened with "flivver" planes for many years to come, but private owners will increase rapidly in numbers. Therefore, it will not be amiss to discuss some of the aspects of private flying.

PRIVATE flying is a sport which needs careful preliminary training. Care is always needed and overconfidence is dangerous. But flight surgeons, flying instructors, and other competent authorities are all agreed that almost anyone can learn to fly who so desires, provided he is young, and has a good physique, quick reflexes, and fair presence of mind.

Skill in driving an automobile, ability to sail a boat, good "hands" on a horse, and skill in rapid games are all good auguries of flying ability. There are many excellent flying schools available, in which one can learn to fly "solo" in 10 hours, and secure the Private Pilot's license of the Department of Commerce. Ways and means can be found of securing the greater experience which is necessary for independent cross-country flying, even in good weather.

Let us now concentrate attention on the first essential of private flying—a good plane. In purchasing an airplane we must look first of all to its flying characteristics. A maximum speed of at least 100 miles per hour is necessary.

THE question of what airplane to buy is one which is of great moment to an increasingly large number of laymen. The available information is meager and is scattered to such an extent that the average nontechnical but airminded person is at a loss as to where to obtain accurate data. True, biased opinions are readily found, but in a matter such as this, biased opinions are to be avoided. For this purpose, the accompanying article was prepared. It will be found invaluable to the aeronautical tyro.—*The Editor.*

Speed is, after all, the main justification of the airplane. It is uneconomical of fuel to fly with engines "all out"—cruising speed is always 10 to 15 percent less than maximum speed, and head winds have to be allowed for.

The landing speed should not be more than 40 miles per hour. A highly skilled pilot can land a racing plane on a specially prepared flying field at 100 miles per hour without damage, but a private owner who wishes to make cross-country flights may have to land in a small emergency field. Low speed lessens the shock of a poor landing, and also reduces the chance of nosing over. Furthermore, a slow landing means that there is less energy of motion to be taken up, and therefore a shorter landing run becomes possible. Planes that land slowly, unless very much under-powered, are also capable of making a get-away after only a short run. This is very helpful where a minor defect has brought the pilot down in a small field.

THE Daniel Guggenheim Safe Aircraft Competition has been established, with a major prize of 100,000 dollars and five minor prizes of 10,000 dollars each, for the express purpose of encouraging progress at the lower end of the performance scale, without undue sacrifice of good high-speed and load-carrying characteristics.

The easiest way to secure low landing speed is to increase the wing area. But a large wing area for a given gross weight means bumpy flying in gusty weather and also entails loss of maximum speed.

The next step in airplane design is therefore to make practical the use of some device to increase the lift capacity of the wing on landing.

Such devices involve increasing the wing area by sliding out a portion of

the wing, turning down the rear portion of the wing in the form of a flap; varying the camber or thickness of the wing, or using the Handley Page slot. All such devices involve some degree of complication and increase in weight; nevertheless they deserve the most careful attention and one or another of these devices will ultimately come into general use.

Very rapid climb is more valuable for a military airplane than for a commercial plane. What the commercial plane needs is the ability to climb at a steep angle so that obstacles such as trees or telegraph poles surrounding a field can be readily cleared. To observers on the ground, the climb of a modern airplane, particularly when climbing into a head wind, may appear very steep indeed. As a matter of fact, the angle of climb seldom exceeds 15 degrees to the horizontal. For steep climb the loadings of the plane in pounds per square foot and in pounds per horsepower should be low; these loadings are perhaps the first characteristics to be determined when purchasing a plane.

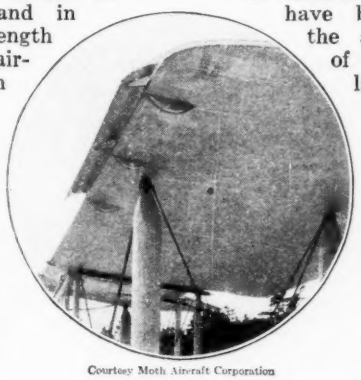
STABILITY in normal flying is another requirement of the Safe Aircraft Competition. A plane should be able to fly "hands off" for several minutes even in gusty air, and there is no doubt that a number of designs already have such stability. If a prospective purchaser is taken up for a trial ride, he may (at a safe altitude) ask for a number of simple tests to demonstrate stability. For example, suppose the stabilizer is adjusted so that the plane flies "hands off" at a certain speed. If the control stick is pushed forward, and then released, the plane should soon return to its original flying attitude and speed. An unstable plane would tend to dive without recovering.

Structural failures in the air are inexcusable. The art of stress analysis is now so well understood, that a plane which satisfies the airworthiness requirements of the Department of Commerce, and whose maintenance is adequate, should never have a structural failure. In military and naval aviation, pilots must, on occasion, impose severe loads on their machines in such maneuvers as pulling out rapidly from a dive, or in the barrel roll in which the wings are rapidly rotated about the longitudinal axis of the airplane. These maneuvers are not needed in commercial flying, and in normal flying the strength of the frail looking airplane is more than adequate.

Accidents due to the aerodynamic characteristics of an airplane are unfortunately not so infrequent as those due to structural failure. Perhaps the most frequent source of trouble is the spinning nose dive following a stall. In this, the lift of a wing increases steadily with its inclination, until a certain maximum is reached. This occurs at an inclination of some 14 to 16 degrees. The air flow then ceases to be streamline, and tears away from the upper surface of the wing. It is said to "burble." If the inclination of the wing increases still further, the lift actually diminishes.

If in flying, the angle of maximum lift is passed, the machine is said to be "stalled." It will drop and start to dive more or less violently. The ailerons become far less operative than in normal flying, and if one wing "falls off," (falls lower than the other), the machine may refuse to come to an even keel, and instead go off into a spinning nose dive.

PERHAPS the very best method of preventing the stall is the use of the automatic Handley Page slot. With this device, as the angle of incidence of the wing increases, the region of maximum suction moves forward, until the resultant pressure on the nose is such that the linkage system moves the slot forward. If the angle of incidence is high, the opening of the slot causes a flow of air from the under surface to the upper surface of the wing, and the extra energy supplied to the upper surface prevents "burbling" or stalling. The automatic slot is therefore the very best safeguard so far devised against stalling.



Courtesy Moth Aircraft Corporation

THE SLOT

The Handley Page slot is a feature especially popular with private owners

A number of English planes have been equipped with the automatic slot. One of these, the De Havilland *Moth*, has been imported into the United States. The automatic slot has been applied only to a portion of the upper wing, but the *Moth* can be flown with ease, at very low speeds, and at an angle of incidence which would be impossible were no slots used. With the use of the slot it should be possible to glide down fairly steeply, with the nose of the machine well above the horizon. This facilitates landing in a small field surrounded by obstacles.

It is to be hoped that American designers will give increasing attention to the possibilities of the slot.

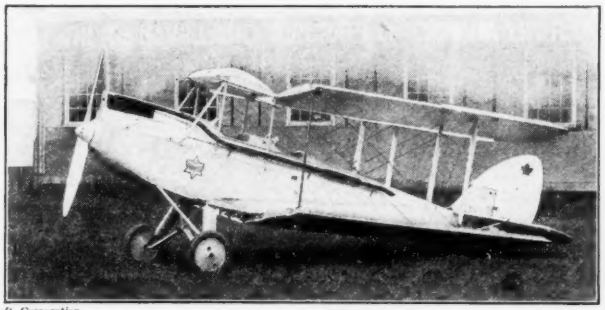
THE tendency in automobiling is towards the closed car, and for very good reasons. In the fairly large five or six seater monoplane of today, equipped with a 200 horsepower Wright Whirlwind, with an expert pilot at the controls, the enclosed cabin is almost universal. But for the small two or three seater privately owned machine, many airplane constructors remain faithful to the open cockpit.

With an open cockpit, the flier-owner can hear and watch his engine better and his vision is never obstructed. The feel of the air on his face, the whistling of the air through the rigging, all this helps the moderately experienced man to fly better. When weather conditions are too unpleasant for open cockpit flying, it is probably best for the average owner not to fly at all. In fair weather the

Courtesy Moth Aircraft Corporation

THE DE HAVILLAND "MOTH"

A small two-passenger plane, equipped with Handley Page slots. It is one of the foreign planes becoming popular in America

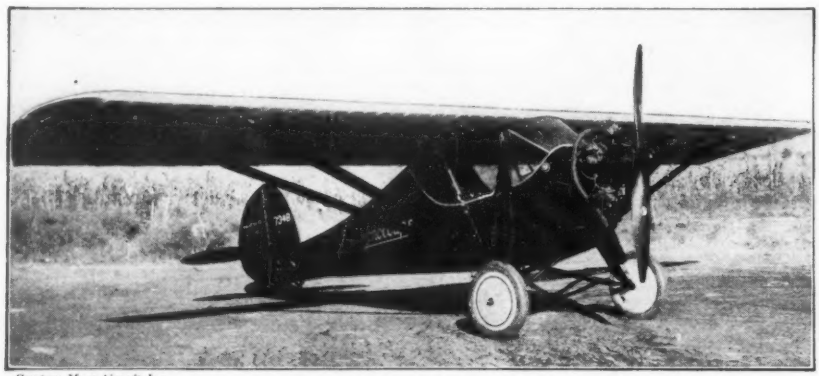


THE WINGS FOLD

The folding wings are especially desirable where limited hangar space is available and for towing through congested streets

open cockpit gives more thrill, more pleasure, and a better view of the earth's carpet.

At one time, after the first low-power plane races in Dayton in 1923, it was thought that the "flivver" plane would become extremely popular, and that planes of 20 horsepower or so, selling at very low prices, would sweep the country. This expectation has not been realized. Very small planes of low wing loadings respond too readily to gusts. The controls need little force to actuate them, yet such ships are really very difficult to fly. Particularly in cross-country work have the "flivver" planes had a checkered career in the United States. They offer the advantages of extreme maneuverability, and the ability to land and make a get-away in very small fields. They are cheap in original price, and their gasoline and oil charges are absurdly low.



Courtesy Mono-Aircraft Inc.

THE "MONOCOUPE"

A two place, enclosed semi-cantilever monoplane equipped with a Velie 45 horsepower motor. An American plane which appeals to the private owner, and is reasonably priced

INSTEAD of the "flivver" of 20 horsepower we shall probably see a large number of 40 to 50 horsepower machines in use. Some very neat planes of this type have been built and flown successfully in recent years.

The Driggs *Dart II* is an excellent example: This neat little biplane has a total wing area of only 140 square feet, and is equipped with a 40 horsepower, three cylinder Auzam engine, yet it can carry two occupants comfortably and has a high speed of nearly 90 miles per hour.

In the small two seater class of between 40 and 50 horsepower there are exponents of the enclosed cabin. Thus the *Monocoupe* has a small neat cabin with side by side seating, although its five cylinder motor is said to develop only about 50 horsepower. The *Monocoupe* has a very distinctive appearance, and 2675 dollars at the factory is certainly an attractive price.

It will be seen from the photograph that the exhaust gases are collected into a ring, and then led into a long pipe underneath the cabin, with its opening well behind the cabin, a protection against noise and exhaust fumes. The gasoline is placed in two tanks in the wings on either side of the fuselage, giving pure gravity feed. Such a position is probably also the best from a fire prevention point of view.

The *Monocoupe* has many other attractive features and should have a large sale to private owners.

The day of the cheap plane with OX-5 engine is past, until another cheap engine finds its way on the market. But these planes have served their purpose in popularizing flying more than any other type of plane.

ONE of the best known machines in the OX-5 class is the *Waco Nine*. Entirely conventional in design, it has, nevertheless, an excellent specification. The useful load is 800 pounds, the maximum speed about 92 miles per hour, and the cruising radius 400 miles.

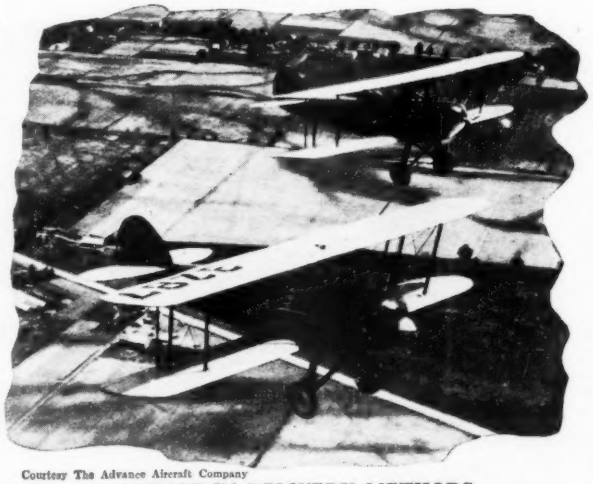
The many air-cooled engines of about the same power as the OX-5 have not yet given the long service of the OX-5 or the Wright Whirlwind, but several very promising engines are on the market. We may expect soon to see in the air a large number of planes costing around 5000 dollars, two or three seaters, and equipped with one or another of these air-cooled engines.

A typical plane of this class is the Taylor Brothers Aircraft Company's new *Chummy*. Powered with a 100 horsepower Kinner, the Taylor *Chummy* weighs 950 pounds empty and has a useful load capacity of 550 pounds, giving a gross weight of 1500 pounds. With this load and a wing area of 175 square feet, it is said to have a top speed of 110 miles per hour and a landing speed of 38 miles per hour. The fuel capacity is 30 gallons and the range at cruising speed, 500 miles.

The private owner may find as time goes on that he wants a little more speed, and more reserve power, particularly when getting out of small fields. The detachable engine mounts of the *Chummy* may then prove useful. Provided weight variations do not appreciably influence the balance, and provided the plane is originally designed to be strong enough to take a more powerful engine, there is a decided advantage in being able to replace a 90 or 100 horsepower engine with one of 125 horsepower.

LIKE golf or any other sport, flying leads to endless discussion. On almost every point in the design of a plane, there are two or more divergent opinions. Whether two-seaters should have side-by-side or tandem seating is a typical subject of discussion. Side by side is more pleasant and sociable. With dual control, communication and instruction between teacher and pupil become easy matters. On the other hand, a side-by-side fuselage must be wider and therefore offer more head resistance. With side-by-side seating, vision in landing can never be quite as good on both sides as in a tandem plane. In the *Chummy*, the side-by-side arrangement has been selected. The width of the cockpit is 38 inches, which is probably quite comfortable.

No private owner should buy a two seater without dual control. Even if he never becomes a pilot, he will find much pleasure in taking the controls occasionally. There is only one danger, and that is that an excited passenger or even a student of some few hours training may try to take control in a tight corner, and "freeze" on to the



Courtesy The Advance Aircraft Company

LATEST IN DELIVERY METHODS

A group of Wacos are being flown away from the factory—a method of delivery popular with airplane manufacturers

controls, causing a serious accident, or at least a few exciting moments.

In the *Chummy*, two sticks and two sets of rudder pedals are used and the right stick is removable. There is a partition between the two sets of rudder pedals, and the student's rudder pedals are mounted on springs. In normal flying these pedals control the plane, but they can be overpowered by the pilot at any time. All the control leads are below the floor. Particularly with the student's stick removed, the pilot need not worry that the passenger will lock the controls.

We have seen that open cockpit versus closed cockpit is another source of controversy. In the *Chummy* an intermediate solution has been obtained. Behind the engine compartment is a high windshield of Pyralin closing the gap between the fuselage and the wing. The windshield is curved so as to reduce the resistance and to protect the cockpit from air spilling over the sides. The occupants are protected in the coldest weather, yet at the same time have ample vision under adverse conditions, and plenty of fresh air, the best preventative of airsickness.

AT high incidence, the ailerons are never quite as powerfully operative as at high speed or low incidence. Also, the drag on the side on which the aileron is pulled down becomes very much greater than the drag on the side on which the aileron is pulled up. Therefore, when the ailerons are used to control a roll, the plane tends to swing badly off its course. A partial remedy lies in the differential controls of the ailerons. In the *Chummy*, the upward moving aileron has a displacement of 30 degrees, while the downward moving aileron has one of only 25 degrees.

Another example of the planes of this class is the Avro *Avian*, which has recently been imported and sold in the United States with real success. It is very interesting to study this example of the best English practice in aircraft manufacture.

The *Avian* is a biplane with folding wings. English designers are quite satisfied that the biplane is just as desirable as a monoplane, and they get results which compare very favorably with our monoplanes.

In the United States, air-cooled engines are practically all of the star or radial type. In the *Avian*, the Cirrus II, a four-cylinder air-cooled engine with all cylinders in line is employed. It is quite certain that the in-line engine will be more generally employed in the future. It allows a very neat streamline for the nose of the fuselage, and the vision of the pilot is less obstructed than in the case of the radial engine. The in-line engine also requires somewhat less mechanical skill for its maintenance.

In the wing structure, the English designers prefer to use a thinner wing than is customary in the American type of semi-cantilever monoplane. This is possible because the biplane lends itself somewhat better to bracing. For the same gross weight, the British designer prefers to use a considerably larger area which is necessary with the thin, low-lift wing.

In these small planes, which respond so readily to the controls, and have so much maneuverability, there is always a temptation to stunt. The *Avian* is designed for a load factor of 8, with which factor the Air Ministry permits acrobatics. A higher load factor than required by the minimum Department of Commerce requirement is always a good point. In instruction, particularly rough usage must be expected at all times.

The landing gear of the *Avian* offers real interest. In the wing structure, two short wing roots are attached permanently to the fuselage. These roots are triangular in plain view, with the base of the triangle formed by the leading edge and the apex at the rear spar hinge. To brace the root against the under-carriage loads, a short diagonal strut runs to the top longeron. When the wings are folded they swing, of course, around the hinge. The point of attachment of the rear chassis strut being situated some little distance out from the hinge, when the wings are folded the upper end of the rear strut moves back with the wing, and in so doing pulls the wheel back with it, and at the same time the wheel moves upward slightly. The combined effect is to lower the machine and to relieve the load on the tail skid. Thus, with the wings folded, the machine can be wheeled along quite easily by one man. Lowering the fuselage also facilitates work round the engine.

Courtesy Driggs Aircraft Corporation

"DART II"

A small two-passenger biplane convenient for the owner of moderate means. Its sturdy construction suggests easy maintenance. It is powered by a 40 horsepower Auzam engine

THE English, as we shall see later in this article, use their light planes for flying tours. It is not surprising to learn that in the *Avian*, a luggage compartment behind the pilot's seat can accomodate two full-size suit cases, with room for tool-kit, spare tire, inner tube, et cetera. Even

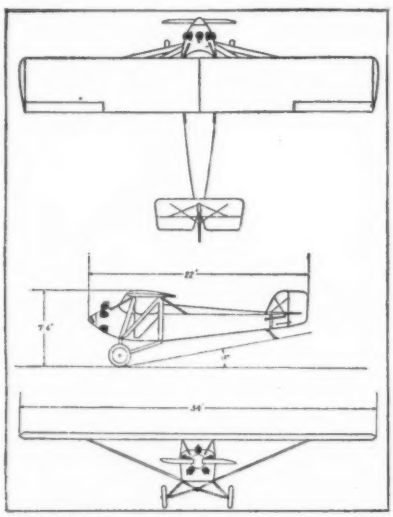
Courtesy Driggs Aircraft Corporation

A HEAD-ON VIEW OF THE "DART II"

This small plane, powered with a three cylinder radial engine, is said to attain 85 miles an hour maximum speed

an emergency propeller can be carried.

As in the *Chummy*, provision against passenger interference is made. The control column in the front cockpit can be removed and the rudder bar quickly disconnected.



Courtesy *Aviation*

TAYLOR "CHUMMY"

A three view sketch showing the general characteristics of this two-place plane

The following characteristics show that the British practice, as regards performance, is neither better nor worse than American practices:

Weight empty	875 pounds
Pilot	160 "
Passenger	160 "
Gasoline	150 "
Oil	15 "
Gross Weight	1360 pounds

Maximum speed—102 miles per hour
Stalling speed—40 miles per hour
Length of run to take-off—225 feet
Length of run after landing—270 to 300 feet
Climb at ground level—650 feet a minute
Range—5 hours, or 430 miles

FOR the sportsman owner who intends to fly his own ship, there is much to be said in favor of the two or three seater with open cockpit. But for the man who intends to employ a pilot and to make long trips, the somewhat more powerful cabin monoplane is preferable. It is likely to cost about 12,000 dollars.

A number of splendid and luxurious closed cabin monoplanes are now available such as the Fairchild *FC-2*, the *Stinson-Detroiter*, the Fokker *Universal*, the *Ryan Brougham*, the *Travel Air 5000*, the Buhl *Air Sedan*, the *Bellanca*, et cetera.

These machines so far have been designed to carry a pilot and four passengers, although several firms are preparing planes with dual control cockpits, and compartments for four passengers.

Fashions in wing structure change quite frequently. Biplanes, cantilever monoplanes, and semi-cantilever monoplanes each have their good points.

A biplane structure suitably braced with struts and wires is the lightest and most compact, but it is not aerodynamically so efficient as a tapered cantilever monoplane in which all struts and wires have disappeared.

The semi-cantilever monoplane, with just two struts going from either side of the fuselage to the wings is a compromise. American designers seem to be in agreement, at the moment, on the all-around advantages offered.

The *Travel Air 5000* is quite typical of the semi-cantilever cabin monoplane. A circular prepared by the Travel Air Company for the N. A. C. A. gives an excellent outline of this plane, with its main dimensions.

The power plant is a Wright Whirlwind J-5-C, developing 230 horsepower at 1900 revolutions per minute. The fuel consumption at a cruising speed of 108 miles per hour is 12 gallons per hour, or nine miles to the gallon, which does not compare unfavorably with the figures for a powerful automobile.

IT has a carrying capacity of one pilot, four passengers, and 50 pounds of baggage, or a pilot and 750 pounds of mail, express, et cetera.

The top speed is 123 miles per hour, and the initial rate of climb is 750 feet a minute. The landing speed is rather high—55 miles per hour. The normal cruising range is about 700 miles.

Fully loaded, the *Travel Air* weighs 3600 pounds, empty—2160 pounds. It is remarkable what a large amount of useful load (pilot, passengers, fuel, and oil) a modern plane will carry, in this case, 1440 pounds or 40 percent of the gross weight of the entire outfit.

The main dimensions of the *Travel Air* are: Span—51 feet, 7 inches; height—8 feet, 9 inches; overall length—30 feet, 5 inches; wing chord—6 feet, 9 inches; wing area—312 square feet. The load per square foot of wing area is high—11.5 pounds. So is the loading per horsepower, which is 15.65 pounds. It is only "cleanness" of design which enables the modern plane to fly with such high loadings.

IN the *Travel Air*, the pilot sits in an entirely enclosed compartment, just as do the passengers, but the modern designer has learned how to give the pilot ample vision. There are windows everywhere—in the doors, on either side, sloping ones at the side of the rudder pedals, and in the cupola over the pilot's head which consists of a V-shaped metal frame rigidly attached to a point just back of the pilot's head. The "V" holds two sliding glass windows which, when opened, afford unobstructed vision forward, with little or no air inflow. This is specially desirable for fog, rain or snow flying, when a stationary windshield would cloud vision.

The pilot's seat is cushioned, upholstered, and adjustable both in height and inclination. In his elevated position the line of sight over the engine strikes the ground at about 75 feet ahead of the airplane when at rest. The height and position of the cupola is such that a large range of vision is available to the rear and below the horizontal. This is desirable because in night flying a sight on the line of beacons to the rear is an aid to navigation. In busy air-traffic lanes it is also an advantage to see an airplane which might approach from the rear.

Another excellent cabin monoplane is the Fairchild *FC-2*. Quite as neat and fast as the *Travel Air*, it embodies the advantage of folding wings. The

Courtesy Taylor Brothers Aircraft Corporation

THE "CHUMMY"

The enclosed cabin is roomy enough to seat two persons side by side comfortably. It is equipped with an 100 horsepower Kinner engine. See also line drawings at left above

two wing struts on either side come together to a single hinge at the fuselage. The wings can swing back about the hinge at the fuselage and the rear hinge of the center section of the machine. The safety locks give the same rigidity as in non-folding types and are located in plain view of the pilot. It is surprising how compact the *FC-2* becomes with wings folded back, and this is an important matter when housing costs and hangar space are considered. The *FC-2* has a landing gear which is interchangeable with twin pontoons. For certain private owners, such interchangeability is a great advantage.

THE large passenger planes now being built by such companies as the Atlantic Aircraft Corporation, Ford Motor Car Company, the Boeing Airplane Company and several others, are much more likely to provide the ultimate in passenger comfort than even the most carefully designed single-engined cabin plane. But the designers of the single-engined cabin plane will, partly of their own volition, partly under pressure of the flying public, constantly improve the design of their cabins. The following are but a few of the desirable characteristics in cabin design:

A special door to the passenger cabin, of easy access from the ground, readily opened, and hinged at its front end so that the blast of air in flying will tend to hold it closed; an emergency exit on the side opposite the entrance door; windows of Triplex glass and designed so as to give perfect vision, even when the passenger is comfortably seated in his chair, extending the entire length of the cabin; heating accomplished by air passing through a pipe around the exhaust manifold or pipe, the air being drawn in at a point where it is not likely to be contaminated by exhaust gas or oil fumes; an attempt at positive ventilation, with all windows closed, air being admitted at floor level. and rising to exits in the top of the cabin.

Positive ventilation is particularly desirable in cold weather, when open windows are likely to produce unpleasant draughts. Positive ventilation also has advantages from the point of view of noise prevention. Silencers are desirable adjuncts and entail far less loss of power in the engine than is commonly imagined. Long exhaust pipes carried well behind the cabin will do practically as well.

But the noise of the propeller, and of the valves in the engine cannot be eliminated. With suitable materials the cabin can be made nearly sound proof, however. The Plane Speaker Corporation, experimenting with Fokker and Sikorsky ships, has found it quite possible to broadcast at heights of 6000 feet. A light, sound-proof cabin was obtained by the use of balsa wool, a fluff wood wool, which has also excellent heat insulating properties. When windows are opened, all the benefits of this sound-proofing disappear. Hence the advisability of positive ventilation.

The airplane designer always seeks to secure better performance by cutting down the outside dimensions of the fuselage. Nothing, on the other hand, is so conducive of passenger comfort as spaciousness. A head room of at least five feet is desirable. With two passengers sitting side by side, a four-foot width would be really comfortable, although a width of three and a half feet is quite permissible.

Even in the single-engine cabin plane it should be possible to provide comfortable wicker chairs with head rests. Air sickness is just as unpleasant as sea sickness and passengers should be able to fight its effects by going to sleep, and sleep without head rests is difficult. It is probably too much to expect adjustable chairs as yet.

Cabins should be so designed that passengers have plenty of leg room. A cramped position is far more unpleasant in an airplane than in the automobile where it is always possible to get out and stretch one's legs.

Chairs should not be such as to injure passengers behind them in case of a crash. Their upper portions should be fairly flexible. Safety belts are not often provided in enclosed cabins, but they are useful in gusty weather and when landing—particularly in a bad landing.

Even in a small cabin plane, it seems advisable to have some division or partition between the pilot's cockpit and the cabin proper, although there should be at all times perfect freedom of communication between them. Passengers should either be able to see the pilot's instrument board, or have an air-speed indicator and an altimeter in their cabin.

A simple washroom is a great convenience, particularly for airsick passengers.

Provision for light baggage, in the form of wall racks, should be made. Heavy baggage should always be housed in a separate compartment, as it can be quite dangerous in case of a crash.

Electric lighting adequate for reading is a great convenience, almost a necessity.

The purchaser of a cabin plane can probably obtain a great deal of amusement as well as information in taking up such points with the pilot-salesman.

THE amphibian—a seaplane provided with retractible wheels, permitting a landing to be made on either land or water—is a type which is of particular interest to the private owner.

Commuting by air is a fascinating idea. Unfortunately, the airport of a great city is generally to be found 10 miles or more from its center, and all the time saved by the aerial commuter is lost in getting from the field to his office. However, in the majority of our great cities, particularly those on the seaboards or on the Great Lakes, water landings may be made within a few minutes' walk from the business center.

For New York, which is more unfavorably situated with regard to its flying fields than any other great city, Clarence D. Chamberlin proposes sev-

Courtesy Air Associates, Inc.

THE AVRO "AVIAN"

A small British plane equipped with Handley Page slots, becoming popular in the United States. Folding wings are another added popular feature. See description on page 209

eral landing points for amphibians. One would be at the Battery at the very tip of Manhattan, and a few minutes' walk from Wall Street. Others would be on the Hudson River at 42nd and 33rd Streets, at points readily accessible to the mid-town centers of the city.

Courtesy Travel Air Manufacturing Company, Inc.

"TRAVEL AIR, 6000"

A four-passenger, two pilot, enclosed cabin monoplane with a maximum speed of 120 miles per hour with full load when equipped with a Wright Whirlwind 200 horsepower motor

Residents of Chicago, Cleveland, Boston, and other great cities will rapidly pick out suitable sites for flying boats in their localities.

In the design of an amphibian, certain sacrifices have to be made. A seaplane is never quite as speedy nor as efficient a load carrier as a land plane. The retractible landing gear is a further handicap. Evidently the amphibian is likely to be considerably more expensive than a land plane of similar horsepower. But these disadvantages are more than outweighed for the private owner by the flexibility and general usefulness of the amphibian.

IN the preparation of this article, we had the pleasure of interviewing Richard F. Hoyt, Chairman of the Board of the Wright Aeronautical Corporation and a partner in the great banking firm of Hayden, Stone, and Company, which has done so much for the organization and financing of American aviation. Mr. Hoyt has owned a private plane for many years, and is now the proud possessor of a Loening amphibian.

In Mr. Hoyt's opinion there will soon be hundreds—even thousands—of private plane owners. "In a Loening amphibian," said Mr. Hoyt, "there is more comfort and convenience, when flying, than in the most luxurious private car. It is possible to read a newspaper, which is certainly more than one can do in a car. The sense of freedom achieved is wonderful. I can reach Cape Cod in two hours flying, while the rail journey from New York takes six."

Questioned about costs, Mr. Hoyt said that a pilot could be obtained for 100 dollars a week, and that one pilot-mechanic was sufficient for both the operation and the maintenance of his large amphibian. Any man who can afford to own a 75-foot motor cruiser, can afford the most luxurious air yacht. In fact, the seaplane is less expensive, needs a smaller number of men and is much less trouble all around. With an amphibian, housing is much less of a problem than the housing of a large motor boat. With an inexpensive hangar, and a simple runway to the beach, an amphibian can readily be stored away when not in use.

An amphibian of medium size is the Ireland *Neptune*, selling around 14,000 dollars. With a 200 horsepower Wright Whirlwind, the *Neptune* has a speed of 98 miles per hour, an initial rate of climb of 650 feet per minute, a cruising radius of six hours and a pay load of 800 pounds.

The landing gear and tail skid are both of the oleo type, providing a nine-inch movement of the shock absorber on the landing gear. For taxi work, a heavy coil spring is provided. The landing gear is swung up around a horizontal axis, until the wheel takes a position immediately below the leading edge of the lower wing. The operating mechanism of the landing gear is of the irreversible worm and gear type and is enclosed entirely within the wing.

The pilot and one passenger sit in the front of the cockpit. Three passengers sit on a spacious seat in the rear. Thick kapok cushions are supplied, one for each passenger, and these can be readily used as life preservers. A spray strip on the wing and a wide splash and walking board which runs from the bow to the leading edge of the wing, protects the passengers from spray.

Such an amphibian, not too luxurious, is an ideal possession for a sportsman.

One of the most popular amphibians of the day is the Loening cabin amphibian, now known as the Keystone-Loening Amphibian Air Yacht which is considerably larger, more luxurious, and more powerful and the *Neptune*. It is equipped with a 525 horsepower Wright Cyclone engine.

With this engine its characteristics are as follows: Span—46 feet, 8 inches; length overall—34 feet, 8½ inches; height overall—13 feet, 2 inches; wing area—517 square feet; weight empty—3950 pounds; pay load—1100 pounds; disposable load—1950 pounds; gross weight—5900 pounds; wing loading—11.4 pounds per square foot; high speed—130 miles per hour; landing speed—55 miles per hour; range—550 miles.

WITH an amphibian it is apparently possible to go to quite a heavy wing loading without undue difficulty. Considering the double handicap of a hull and a landing gear, it is really remarkable what a high performance is attained with this type of craft.

Since the Keystone-Loening cabin amphibian is an expensive air yacht, perhaps our readers will be interested in learning what can be done in the way of finish, passenger comfort, and accommodation, which *Aviation* describes very thoroughly:

The external coloring is high visibility orange in contrast with a black hull and black cowling at the top of the cabin. The wings and tail surfaces are of orange with black struts and bracing members. All external bracing wires

THE "TRAVEL-AIR" CABIN

A spacious interior. Flying is made more interesting to the passengers by the full view of the cockpit

and fittings are either polished duralumin or nickel plated steel. The finish resembles that of a yacht and the colors are such that the plane can be seen at a considerable distance.

The cabin is upholstered in the manner of an expensive motor car or boat, with a baggage compartment forward and a small lavatory in a separate compartment in the rear. The interior finish is lavish, fittings are nickel plated, and walnut trim is used around the windows.

The doors on each side are high, and

Courtesy Atlantic Aircraft Corporation

THE MODERN FLYING OFFICE

A famous designer, A. H. G. Fokker (facing camera) in the cabin of a Fokker tri-motor

the roof of the cabin above each door slides up to increase the head room for entering or leaving the plane.

The sliding roof in combination with the side windows permits almost any kind of ventilation desired. The side windows slide vertically. An exhaust heater is provided for cold weather, controlled by a shutter in the cabin at the front near the floor. Swivel chairs are provided and a collapsible table can be mounted in the center of the cabin; magazine racks and an automatic cigar lighter are provided.

On the Keystone-Loening amphibian, a muffler unit of the Venturi type is used, consisting of three concentric cylinders, the inner two perforated, so that the exhaust gases, entering on one side, whirl at the same time as they expand. The innermost chamber produces the Venturi effect because of its taper. The gasses pass from the chamber between the outer two cylinders to the one between the inner two cylinders and thence inside the inner cylinder, expanding and reducing the noise and flame when passing through the holes from one chamber to another. The Venturi sucks the gases through the system and is said to have increased the speed of the Wasp engine on the ground from 1630 to 1660 revolutions per minute, so that the contention of decreased power due to muffling fails completely when applied to this type. The muffler is above the slipstream and far from the cabin, thus reducing the noise to a minimum.

To reduce the noise further, the cabin walls are padded with balsa wool. A heater of the "muff" type is also included with the exhaust system. It consists of a sheet of metal or "muff" wrapped round the exhaust manifold. An opening on one side receives the air where it comes in contact with the manifold. The air then passes through an opening on the other side which is connected to a pipe leading to the cabin.

THE "muff" is in contact with the exhaust pipe for only about three inches but is said to give a constant current of air to the cabin at about 75 degrees, Fahrenheit, on a moderately cold day.

The air yachtsman has some of the problems of the sailor to meet and similar accessories to provide. Below the engine mount at the front of the body in the Keystone-Loening amphibian is a compartment with ample room for about 300 pounds of baggage. Just behind the door to this compartment is a small compartment containing a collapsible anchor and anchor rope, and a cleat for fastening the anchor rope.

To such marine equipment, particularly in large flying boats, we shall presently see added emergency rations, smoke bombs useful in traveling over lonely waters, a marine rudder, perhaps a marine propeller with auxiliary engine, radio sets which will function when the seaplane is down in an emergency, and perhaps a jury mast with auxiliary sails.

THE INTERIOR OF A FOKKER

Tri-motor *F-10*, showing the comfort that modern airplanes are providing

Just as in the automobile, there is no end to the accessories and equipment which may be purchased. A well-equipped instrument board such as shown in our photograph should carry:

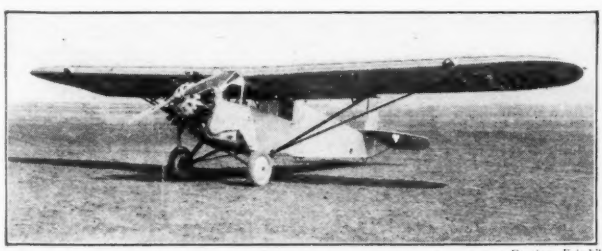
Oil pressure gage
Oil temperature gage
Fuel pressure gage
Fuel level gage
Tachometer
Clock
Altimeter
Air speed indicator
Magnetic compass.

FOR cross-country flying it is convenient to have a drift and ground speed indicator and a bank and turn indicator, map case, et cetera. For night flying, navigation lights, landing lights, and parachute flares are essential. For flying over long stretches of water a collapsible life boat and a smoke-producing apparatus contribute to safety.

Radio sending and receiving equipment is a luxury that probably few private owners will invest in as yet.

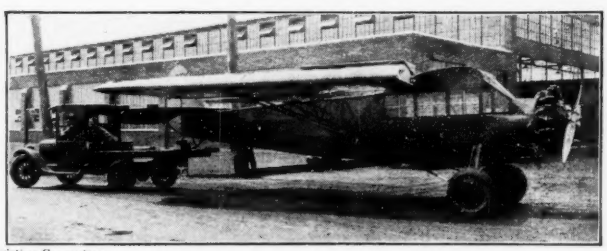
On the plane itself, wheel brakes, a metal propeller, automatic fire extinguisher for the engine compartment, and a dump valve for the gasoline are desirable.

As a rule, the purchaser of a modern



FAIRCHILD MONOPLANE

One of the popular monoplanes with a 410 horsepower Wasp motor, capable of 140 miles per hour, carrying four passengers



Courtesy Fairchild Aviation Corporation

THE AUTO AND THE PLANE

A Fairchild airplane being towed to a landing field. Without the folding wings, this feat would be impossible on the highways

plane will find the minimum necessary equipment already installed. To the possible number of accessories and the money that may be spent there is, as in the case of the automobile, practically no limit. The private owner should confine himself to what is strictly necessary at first and only expand his equipment as his flying objectives become more ambitious.

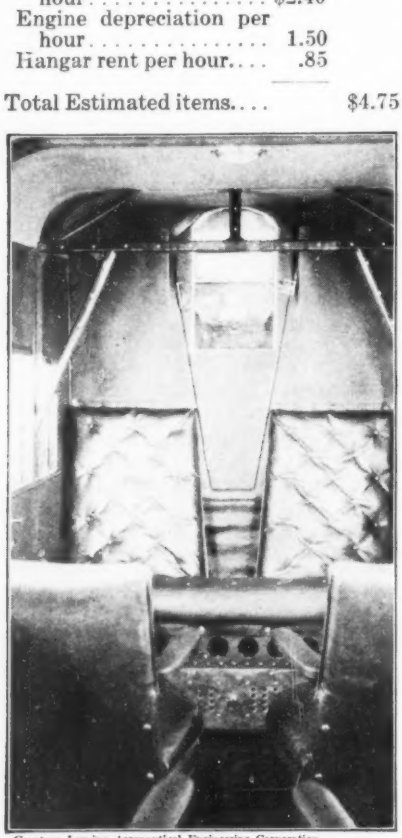
IN air-transport operations, cost accounts are now kept with considerable accuracy. In private and school flying, there is a tendency to disregard costs. Therefore the figures given in a recent issue of *U. S. Air Services* for operations conducted by Robert Rhea, of Colorado Springs in a school known as Pikes Peak Flying School will be informative reading to the prospective private owner, even if interested in a plane of quite another type than that used by Mr. Rhea.

Two Alexander *Eaglerock* OX-5 engined, two-seater planes were used for school purposes. The planes cost 1700 dollars each, the engines 450 dollars each.

For a period extending from September 17 to December 1, 1927, the following are given as the per hour figures:

Estimated Items

Plane depreciation per hour	$2.40
Engine depreciation per hour	1.50
Hangar rent per hour	.85
Total Estimated items	$4.75



Courtesy Loening Aeronautical Engineering Corporation

INTERIOR OF AMPHIBIAN

Closing off the pilot's cockpit from the cabin increases the comfort of passengers

Actual Items

Gas and oil	$1.36
Mechanic's Salary	2.08
Pilot's Salary	5.00
Advertising	.50
Postage, et cetera	.53
Repairs — engine and plane	3.61
Other Expenses	.30
Total actual flying items	$13.38
Total cost per hour	$18.13

The above figures represent 200 hours of actual flying. Hangar and field rent were 25 dollars a month for each plane.

THE depreciation figures were purposely set high, so as to permit the use of new equipment at all times and increase the margin of safety. This was justified by results. Even though each student made cross-country flights of 45 miles, and 3000 flights were made, not a single forced landing was recorded.

Estimating the cruising speed to be 85 miles an hour, the cost per mile was 22.4 cents. Disregarding depreciation, pay of pilot and mechanic, and other items not taken into account by the private owner, the cost per mile figures out to be 6.8 cents.

This low figure will not apply generally. Planes even of the 90 horsepower class will now cost more. A large cabin monoplane will involve far more expense all around. A private owner may have a bigger repair bill than a rigidly run school, but to one who is accustomed to a fairly expensive automobile, such an outlook will not be terrifying.

The prospective owner may also be interested in a more direct method of figuring costs, based on practice at Curtiss Field, Long Island.

For a plane in the 100 horsepower class, hangar space will cost 35 dollars a month. Washing down the plane, draining oil, and other servicing will cost another 20 to 25 dollars a month.

Courtesy Loening Aeronautical Engineering Corporation

THE LOENING AMPHIBIAN

A military type amphibian converted for use in the commercial private field. The exhaust ont he top of the wing incorporates a silencer of unusual design to reduce exhaust noises

The frequency of engine overhaul depends on the amount of flying. An overhaul every five to six months at a cost of 75 dollars for the engine (to include cleaning cylinders of carbon, grinding down valves, et cetera) is a reasonable estimate. Overhaul of the plane should run to about the same figure, but need not be so frequent. Crash insurance may be computed at under 20 percent per annum of the value of the plane. Depreciation should be figured at 33 per cent per annum. Ten dollars a week is a generous allowance for fuel and oil.

With careful use, the owner-pilot of a 3000 dollar plane should be able to carry on indefinitely with an expenditure of something like 2000 dollars per annum.

The expenses of an owner who has his own hangar and repair shop, and his own pilot will, of course, be very much heavier. The cost of a small hangar is not very great, and the equipment needed is not large—a bench, a vise or two, a kit of tools, and a few spare parts. But even the owner who has to rely entirely on his own resources will find his expenses fairly heavy.

IT seems much more practical to station one's plane at a regular flying field, where "garage" and service are readily available.

While there have been and are now in existence in the United States, a large number of aviation clubs, with club rooms for social purposes, aeronautical libraries and frequent meetings for the discussion of aviation problems, there have been few attempts to maintain real flying clubs.

To enthusiasts about to form a flying club, the experiences of Mr. Rhea will again be interesting. After his successful experience with his school, he organized a non-dividend corporation under the name of Pikes Peak Flying Club. The following rates were established:

Courtesy Ireland Aircraft, Inc.

THE IRELAND AMPHIBIAN

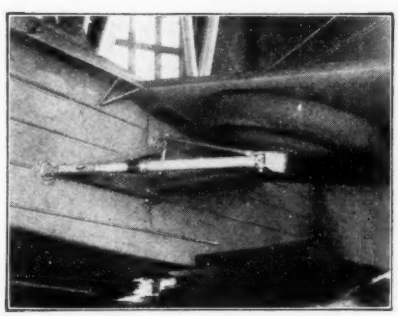
A plane, equally at home on land or sea. The wheels are retracted under the wing when the amphibian is to land on water. An ideal all around plane for the private owner

25 dual instruction lessons of 25 minutes each	$250.00
30 solo tickets, good for 20 minutes each	150.00
Hop tickets	5.00

Appointments for dual instructions were carefully made, instruction having precedence in the morning, hops in the afternoon. A bond of 1500 dollars was required for solo work, and 250 dollars on dual instruction, as an insurance against carelessness or misuse of equipment. Quoting from *U. S. Air Services*, "Gross revenue in the first two months from student work and hop tickets was 9000 dollars. Out of each hop ticket, Captain Zimmerman was paid $1.25 and the mechanic 35 cents. Starting with one plane, a second *Eaglerock* was bought within four weeks. Then a small office-clubhouse was erected on the field. After 14 weeks' operation the club owned 7000 dollars worth of equipment and owed only 1600 dollars. It will not be long until the enterprise will be self-supporting and free from debt."

This experience is very encouraging to a group seeking to form a club.

IT is a sign of the times also that co-operative ownership of the club plane is appearing. Thus the members of the "Wise Birds Club" have developed an original scheme for securing the advantages of airplane ownership, with costs reduced by division among several men. The members of "Wise Birds Club" are five prominent business men: Frank W. Blair, president of the Union Trust Company; William B. Stout, designer of the Ford Metal Airplanes; Newton Skillmann, president of the O and S Bearing Company; Carl H. Keller, president of the Contractor's Equipment Company; and Charles B. Bohn, president of the Bohn Aluminum and Brass Company, all of Detroit. These gentlemen shared equally in the original cost of a *Stinson-Detroiter*, which was about 11,000 dollars. When a member of this group uses the plane, he pays for the gasoline and oil, and pays for depreciation on an hourly basis. At the end of the month, maintenance and repair bills are divided among the members in proportion to their flying hours.



IRELAND LANDING GEAR

The land supplement of the amphibian landing gear is shown here retracted

London *Flight* has a special section of its weekly issue devoted to private flying. The following reports of the doings of flying clubs make most interesting reading.

"Well-known fliers give special exhibitions. Clubs give jolly dinners and dances. Prominent citizens give planes to local clubs. 'The Hampshire Aeroplane Club' made its total of 692 hours in one year with only two machines. Sixty members are flying solo, 32 of whom have been trained *ab initio* by the instructor, Flight-Lieutenant Thomson. There is not a single accident to record. Finally, the social conditions have been improved. There is now a fine club-house.

"The Suffolk Aeroplane Club started last August. Its work for the year was done without official financial assistance. Only one machine was in use, and 99 hours were flown. A large sum has already been subscribed towards the purchase of another machine. Its need is very urgent. Membership of 50; soloists trained—four. There were no fatalities. Lady Bailey is the President.

"The Scottish Flying Club trained 40 members, gave many dances. The purchase of another machine is one of the present objectives and a Club Badge has been designed and will be issued shortly at a nominal charge to cover the cost.

"The Cinque Ports Flying Club carried 350 joy-riders on Good Friday to replenish its finances, famous test pilots giving the hops."

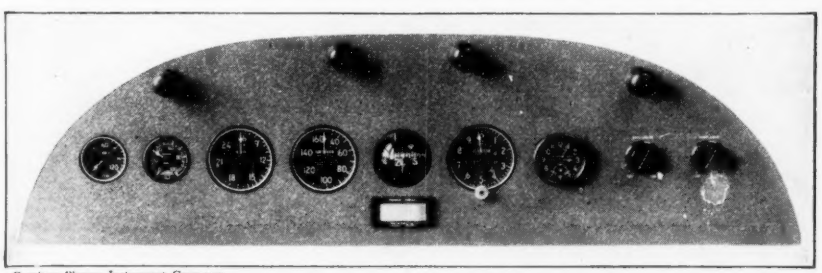
WE have given these disjointed notes on English private flying because they point the way to what we ought to see and shall see in the United States.

The increased safety of the airplane and the great increase in the number of landing fields are now leading many sportsmen and other well-to-do men to think of private ownership.

Young America wants to follow Lindbergh and fly. Flying schools all over the country are besieged with applicants. As soon as a young man has learned to fly, he wants to have his own plane.

Private ownership is also of interest to doctors in sparsely populated districts, ranchers, prospectors, surveyors, and to men in many other occupations.

It can be predicted without much hazard, that there will be both a steady and a rapid increase in the use of airplanes for private flying.



Courtesy Pioneer Instrument Company

PIONEER INSTRUMENT BOARD

An oil pressure gage, an oil temperature gage, an engine tachometer, an airspeed indicator, a compass, an altimeter, and a good clock are necessary adjuncts to a plane of any type

Does Our Universe Rotate?

Accumulated Evidence Indicates that the Whole Galaxy of Billions of Stars Rotates in About 100,000,000 Years

BY HENRY NORRIS RUSSELL, PH. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

IF one looks over the table of contents of the latest volume of one of the astronomical periodicals he is likely to find one or more papers which deal with the "rotation of the Galaxy." This topic, although quite a live one at present, has not been discussed before in these columns.

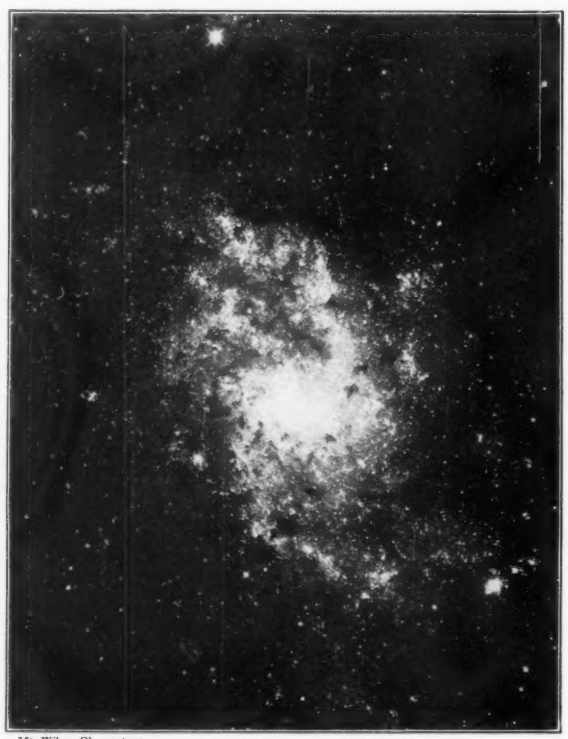
The world has known for a century that the great mass of stars which forms the Milky Way is flattish in shape, with a diameter several times its thickness. The most natural explanation of such a shape is that the great cluster is flattened by its own rotation—as the earth itself is, but to a very much greater degree. Theoretical calculations based on this idea are no novelty but to test their results by observation is hard.

IN the first place the rotation of the Milky Way must be exceedingly slow. An elementary calculation shows that the rotation period does not depend on the size of the cluster or greatly on its shape, but mainly on the density with which the stars are scattered within it. We know about how massive the stars are, and about how far apart, and it follows at once that a single revolution of the galaxy must require at least a hundred million years.

This seems at first sight to dispose of the matter as hopeless. But the rate of a whole turn in a hundred million years corresponds to more than a second of arc in a century; and astronomy has at its disposal observations of the stars which run back for more than a century and are accurate well within a second. Taking the average of a large number of these we might hope that the efforts of the random motions of the stars would average out, and those of the general rotation of the system remain.

But here another difficulty appears. All the stars which have been observed, belong to the Milky Way and share the general rotation. What fixed standard can we find from which to measure their motion? Our ordinary observations tell us where the stars are, compared with the celestial equator (which is nothing but the plane of the earth's equator carried out into the heavens). If the earth's axis always pointed exactly in the same direction, that would give us the standard of reference. But everyone knows that it does not; it shifts steadily so that the pole which it marks out on the sky revolves about the pole of the ecliptic (fixed by the earth's orbit) over a little less than 26,000 years. From the ordinary human standpoint this precessional motion is slow, but from our present point of view it is extremely rapid. Before anything can be said about the rotation of the Galaxy, this shift of the earth's axis must be most carefully measured and accurately allowed for. Fortunately this can be done, although the calculations are long and wearisome; and so we have the earth's orbit to measure from instead of its equator. But even this shifts slowly as the other planets change the orbit by their attraction.

Once more a mass of calculations are necessary, but this time we find ourselves at last with something fixed from which to measure. There is a certain "invariable plane" in the solar system—which may be regarded as a sort of average of the planes of all the planetary orbits — and this is unchanged despite all the perturbations of the orbit which result from the mutual attractions of the planets. Our calculations may be framed so as to reduce our observations to this as a standard, and here we have something which can be shifted only by the attraction of the stars themselves. This, however, can be calculated and turns out to be far too small to worry us.



Mt. Wilson Observatory

A ROTATING UNIVERSE

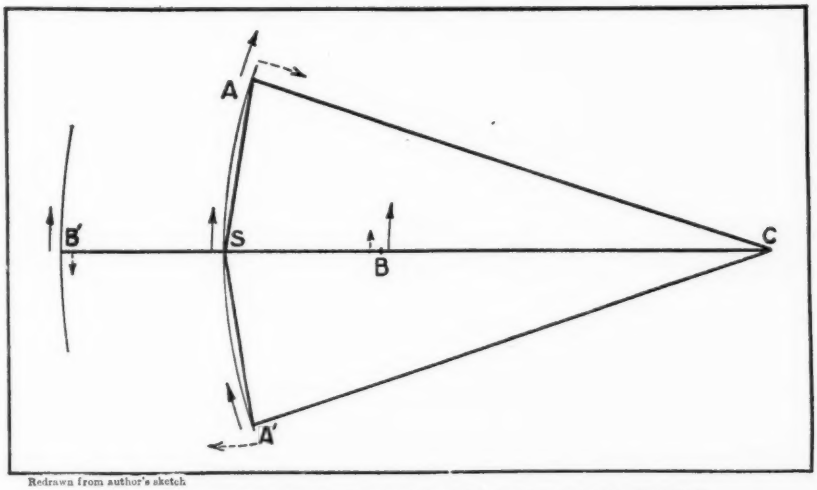
Spiral nebula M-33, in Triangulum, possibly resembling our own universe, the Galaxy. Lundmark believed he found this spiral nebula to be slowly rotating

SEVERAL investigators have gone through the heavy work of calculation, using different groups of stars whose motions have been accurately determined, and all agree that there is evidence of a very slow rotation of the whole system of stars in the opposite direction from that in which the sun and moon circle the heavens. The calculated periods of rotation vary fairly widely from 200 million to more than 400 million years, but they are of quite the magnitude that was to be anticipated from dynamical considerations. Indeed, it is incredible that the Milky Way as a whole should rotate much faster than this; if it was started going as fast as one turn in 50 million years, the stars would be sent flying away into space so fast that the attraction of the whole mass could not pull them back again.

So far, so good. But where is the center around which the rotation takes place? This looks like a harder question still, but it has been solved by two able young continental astronomers, Lindblad of Sweden, and Oort of Holland, in a remarkably pretty fashion. It is probable, as we told in these columns last month, that the

great star swarm of the Milky Way has a central condensation in which much of the attracting mass is contained. The outlying stars would then pursue orbits around this mass as the planets do about the sun. As in the case of the planets the more distant bodies with larger orbits would take longer to go around—so much longer, indeed, that their velocities in miles per second would be smaller the farther from the center they were. This would produce curious effects upon the apparent motions.

Let us, for the sake of simplicity, consider our stars moving in circular orbits around the center C (upper drawing) of the Galaxy. (Motion in elliptical orbits introduces complications which, however, average out in the mean of a large number of cases).



Redrawn from author's sketch

ATTEMPTING TO "SEE THE WOODS, FOR THE TREES"

If we had some convenient way to back away from our galaxy a few million, million, million miles it might be seen as a whole. Unfortunately we must figure it out from where we are

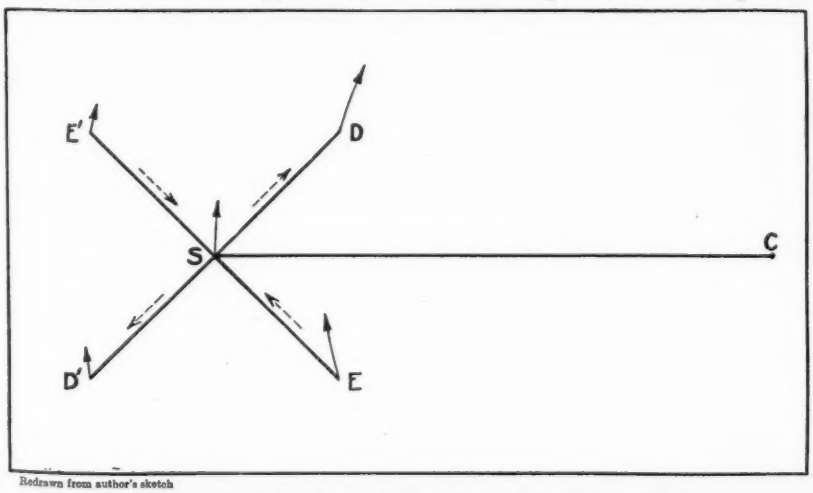
LET us represent the Sun, S, moving in its huge orbit around C in the direction and at the speed indicated by the arrow. Let A be a star at the same distance from the center but ahead of the sun on its track. Its orbital motion will be at the same rate, and hence the whole triangle C S A will swing around the center uniformly. The line S A, therefore, will deflect slowly to the right and A, as seen from S, will appear to sweep slowly to the right in the heavens as is indicated by the dotted arrow. For a star A′, on the sun's track and behind it, the apparent motion will also be to the right and at the same rate.

Consider now the star B, between the sun and the center. Its real motion (shown by the solid arrow) is in the same direction as that of S, but faster. It will therefore overtake S, and for an observer moving with the sun, it will appear to drift to the *left*, as the dotted arrow shows. A star outside the sun at B′ will be moving more slowly; the sun will overtake it, and it again will drift apparently to the left. These backward drifts will be slower than the forward ones at A and A′, so that the average for stars all around the circle comes out in the correct direction.

When the observed motions of the stars are examined in detail, it is found that they show exactly the behavior which our diagram predicts.

In the opposite quarters of the heavens the average motion is forward (that is, in the sense of the general rotation already discussed). In the regions 90 degrees from these it is backward but considerably slower.

A quite independent test may be obtained from the spectroscopic observations of the radial velocity of the stars (their approach or recession). It is evident from the diagram that stars A A′ will not be changing their distance from the sun. No more will those at B and B′, since their motions are at right angles to the line of sight. But suppose we have a star at D in the lower diagram. It is moving faster than the sun (as the arrow indicates) and thence will recede from it. On the other hand, the star at E, which is also moving faster than the sun, will approach it. A star at D′ (opposite to D) will move more slowly than the sun: the sun will run away from it and once more it will appear to recede; while one at E′ will be overtaken by the sun and approach it. These motions are indicated by the dotted arrows which show whether the distance is increasing or decreasing. Here again we get an effect which is the same in opposite parts of the Milky Way and reversed in direction at points 90 degrees from the first. But in this case the regions where the effect is a maximum are shifted 45 degrees from those which show a maximum effect on the proper motions.



Redrawn from author's sketch

THE SECOND SOLUTION AGREES WITH THE FIRST

Both drawings are explained in detail in the text. As in many problems that first seem hopeless, a solution was forthcoming after attack. A scientist is essentially a kind of detective

ONCE again the observations reveal just such an effect, changing signs in the way predicted by theory; and what is more, showing a shift of about 45 degrees from the direction given by the proper motions.

One further test remains. The direction toward the center C, (first diagram) is evidently in the middle of one of the regions B and B′ when the apparent drift of the stars is backward. Which one of these two opposite regions should be taken cannot be determined without some additional evidence. But this is forthcoming—one of these directions is very nearly that of the great star clouds in Sagittarius. There is a great deal of independent evidence—some of which we spoke of last month—to show that the center of the Galaxy is in this direction, and the agreement is close enough to afford further support to the hypothesis of rotation.

The cumulative weight of all this evidence is such that belief in an actually observable rotation of the Galaxy is now very generally accepted.

SCIENTISTS, OFFICERS, CREW, SUBMARINE

The personnel of the expedition, assembled on the deck of the *S-21* at the Washington, D. C., Navy Yard immediately on their return from a two months' trip to southern waters for the determination of gravity at sea. Dr. Meinesz is seated on the rail at the reader's right

Weighing the Earth From a Submarine

The Purpose and Scientific Significance of the Determinations of Gravity at Sea Recently Given Wide Publicity by the Press

By WILLIAM BOWIE, C.E., Sc.D.

President, Section of Geodesy, of the International Geodetic and Geophysical Union
In Charge, Division of Geodesy, United States Coast and Geodetic Survey
Author of "Isostasy"

DR. F. A. VENING MEINESZ, the great geodesist of Holland, who is the only man in the world to design an apparatus for determining gravity at sea with a satisfactory accuracy, has to his credit a string of gravity stations encircling the earth, and has just completed an expedition into the Atlantic, the Caribbean Sea, and the Gulf of Mexico, on an American submarine, the *S-21*, assigned by the Secretary of the Navy. Gravity observations were made over the Nares Deep to the north of the island of Porto Rico, the Bartlett Deep, lying to the south of Cuba, and the Sigsbee Deep, in the Gulf of Mexico.

There are many deeps, or troughs, under ocean waters of which we know much; but what caused them and whether they are permanent features of the ocean bottoms are problems unsolved. In or near them some of the greatest earthquakes occur—why, we do not know. We hope the values of gravity obtained by Dr. Meinesz and his colleagues may throw much light on these strange depressions of the earth's surface.

For many years the value of the earth's attraction, or gravity, has been determined by noting the time it takes for a pendulum to make its swing. The faster the movement, the greater the value of gravity. Until recently the pendulum could be used only on land where a firm support could be obtained.

IN 1923 Dr. F. A. Vening Meinesz, a member of the Goedetic Commission of Holland, started on an epoch-making expedition from Holland to Java, in the East Indies, on a Dutch submarine, with a complicated pendulum apparatus for determining values of gravity at sea. This apparatus was the outcome of Meinesz' gravity measures in Holland, where the land is in many places unstable. There are microseisms due to the force of wind and to the waves of the North Sea, which seriously affect the time of swinging of the usual type of pendulum. He found that by swinging two pendulums simultaneously in the same plane but in opposite phase he could obtain a record from which the effect of the earth tremors would be eliminated.

It was only a step to use the new apparatus on a boat after having found that it could be used on unstable land. But the boat would have to be much steadier than usual. The roll and the pitch of the boat in even a moderate sea would toss the pendulums around and prevent making good records. This difficulty was obviated by using a submarine submerged to such depths that it would be free from the wave action at the surface. By experimentation it was found that the water is quite still at depths below about 70 feet.

The voyage to Java was highly successful. Many observations were made, which for the first time furnished accurate values of gravity over ocean waters. Later on Dr. Meinesz redesigned the apparatus in order to make it especially adaptable to sea work. In the present apparatus there are three short pendulums swinging in the same vertical plane in almost the same period of time. The pendulums are enclosed in a case, which is mounted in a cradle, which in turn is suspended from gimbals. The gimbals rest on a frame which is made fast to an upright beam or to the deck of the submarine.

The pendulum case and the photographic apparatus used for recording the pendulum swings, are fastened rigidly together. A series of mirrors and prisms attached to the pendulum heads and to the supporting framework receive rays of light and reflect and refract them on to the moving film. There are actually rays coming from the mirrors of five pendulums, all in the same case. Three of the pendulums swing freely in the same plane. In a parallel vertical plane is a fourth pendulum which is heavily damped to prevent any movement except that caused by the tilting of the case; while a fifth one, also heavily damped, swings at right angles to the others.

THE photographic records from the three pendulums swinging in the same plane enable one to derive the times of oscillation of what may be called two hypothetical pendulums which are free from the effect of the horizontal acceleration of the apparatus. The records from the fourth and fifth pendulums show the inclinations of the plane of the three swinging pendulums to the vertical and the inclinations of the pendulum supports in that plane. From the photographic records from these two pendulums the effects of the tilting and of the amplitude of oscillation are computed and applied to the periods of the hypothetical pendulums.

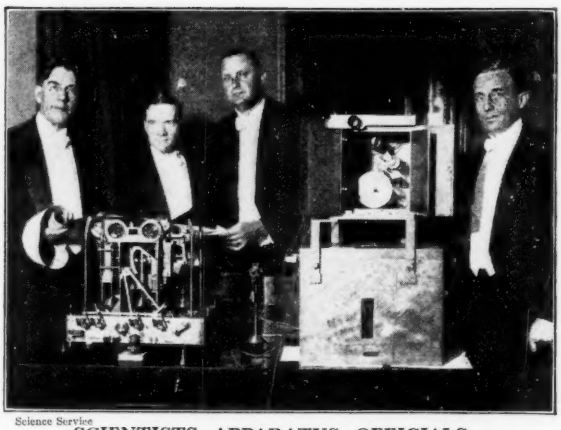
Observations are made during a period of about 30 minutes, while the submarine is held at an even depth. In order to maintain this uniformity the boat is run at a slow speed, for otherwise it would either rise to the surface or sink. The value of gravity obtained is therefore the average along a line one or two miles in length.

The times of oscillation of the pendulums are obtained by comparing the oscillations with two high-grade chronometers, whose seconds' beats are recorded photographically with the pendulum observations. The chronometer rate is determined from radio time-signals sent out by a number of astronomical observatories, such as the Naval Observatory at Washington. Corrections are applied to the observed gravity in order to reduce the value to what it would have been at the surface of the sea. The value changes one part in a million for ten feet of depth. Another correction is needed to eliminate the effect of the speed of the ship on the centrifugal force due to the earth's rotation. The gravity value obtained is greater when traveling westward, and is decreased when the boat moves eastward.

The latitude and longitude of the place of observing is determined by the navigator of the ship. This is a matter of importance since the value of gravity increases with an increase in latitude; and besides, those making geophysical investigations must know the relation in geographical positions of gravity stations to the irregularities of the ocean bottom.

THE 1923 voyage of Dr. Meinesz on the submarine *K II* of the Dutch Navy extended from Holland to Java via the Mediterranean Sea, Suez Canal, Red Sea, and the Indian Ocean. Upon his return to Holland he made some important changes in his apparatus which occurred to him as a result of his experience in the voyage to Java. His next important voyage was on the *K XIII* from Holland to Java across the Atlantic and Pacific Oceans, via the Panama Canal. This voyage occupied 200 days, of which 114 were spent at sea, while for the others the submarine was in port. Among the stops en route were the Azores, the Canaries, Curaçao, Panama, San Francisco, Honolulu, Guam, Japan, and Manila.

In February, 1927, Dr. Meinesz made his next voyage, lasting several weeks, in the Indian Ocean to the south of Java. This voyage was undertaken to obtain values of gravity over the Java trough or deep, which for many years has been a puzzle to geologists who have tried to explain the great irregularities of the earth's surface in the East Indies region. Dr. Meinesz' latest voyage, made recently in the submarine *S-21* of the United States Navy, carried him into the Atlantic, the Gulf of Mexico, and the Caribbean Sea.



Science Service

SCIENTISTS, APPARATUS, OFFICIALS

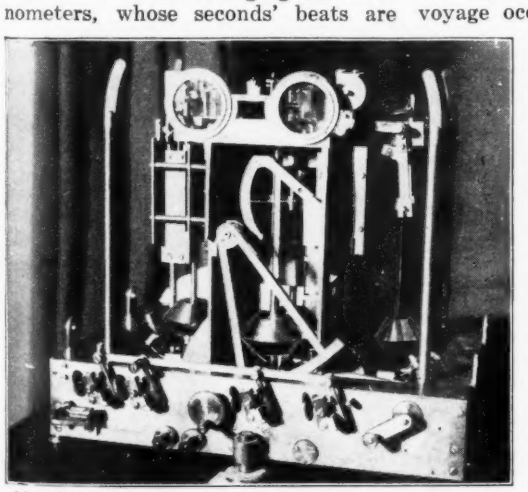
Left to right: Secretary Wilbur; gravity apparatus; Capt. Freeman; Dr. Meinesz; recording apparatus; Dr. Wright

Dr. Meinesz' results on his four voyages on Dutch submarines attracted the attention of the scientific world and naturally the geophysicists and geologists of other countries had hopes that the submarines of their navies might be used for gravity work at sea. In the spring of 1928 informal conferences of Dr. A. L. Day, Director of the Geophysical Laboratory of the Carnegie Institution of Washington, and Captain C. S. Freeman, Superintendent of the United States Naval Observatory, resulted in Secretary Wilbur of the Navy promising a submarine if the Carnegie Institution would invite Dr. Meinesz to come to America with his pendulum apparatus.

Dr. Meinesz accepted Dr. Day's invitation and the submarine was made ready. He arrived in Washington the latter part of September, made observations at the gravity base station at the office of the Coast and Geodetic Survey in that city, and then installed the gravity apparatus in the *S-21*, which had been brought to the dock at the Washington Navy Yard.

DR. F. E. WRIGHT, a member of the Geophysical Laboratory, and Mr. E. B. Collins, of the Hydrographic Office of the Navy, joined Dr. Meinesz on the voyage of the *S-21* in order to assist him in the observations and computations and to become thoroughly familiar with the gravity apparatus, and how to observe with it should our Navy undertake other voyages for gravity observations after Dr. Meinesz returns to his hone.

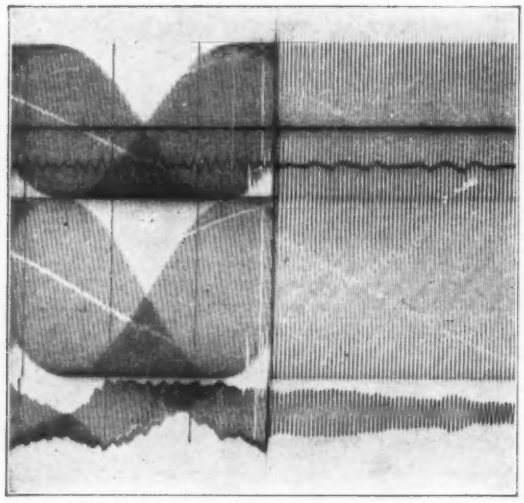
After the pendulum apparatus was in place, the *S-21* was visited by Secretary Wilbur, Admiral Hughes and other officers of the Navy, and by many of the scientific men of Washington. In spite of the cramped quarters and the smallness of the boat, favorable response would have been



Science Service

THE HEART OF THE APPARATUS

Three of the pendulums are visible. These are ten inches long and are mounted on jewel knife edges



A TYPICAL PHOTOGRAPHIC RECORD

Seven values, representing times of swing, tilting of apparatus, and temperature of pendulums, are shown

made by many of those present had there been a call for volunteers for the voyage.

The *S-21*, with Lieut. J. L. Fisher in command, left the dock on the afternoon of October 2nd, without the booming of cannon but with all good wishes of those scientific workers of America who knew of her mission. She sailed out into the Potomac and headed toward the sea on a voyage to conquer earth secrets, and to throw light on some of the most baffling of earth problems.

THE submarine was joined at the mouth of the Chesapeake Bay by the Eagle boats *No. 35* and *No. 58*, commanded by Lieut. Comdr. T. L. Nash and Lieut. Comdr. L. R. Moore, respectively. The voyage was planned in a most efficient manner and all went well. The Commander and other officers and the members of the crew of the *S-21* took intense interest in the work and did their part well. They received the highest commendation and praise from Dr. Meinesz at the conclusion of the voyage.

The *S-21* tied up at the Washington Navy Yard dock on November 27th. All on board were happy, although tired, after two months of intensive work in close quarters and much buffeting by rough seas. A splendid, epoch making expedition was ended, and the results obtained are of great scientific value. We feel that this is only the beginning of the use of American submarines on gravity surveys.

THE earth is a globe about 8000 miles in diameter, flattened at the poles and with a surface of about 197,000,000 square miles, of which 140,000,000 are covered by water. The surface is represented by high mountains and plateaus, with the greatest elevation above sea level slightly more than 29,000 feet, and by ocean basins having great ridges, shelves and troughs. The greatest depth found is more than 35,000 feet in the trough just to the east of Mindanao, an island of the Philippine Archipelago.

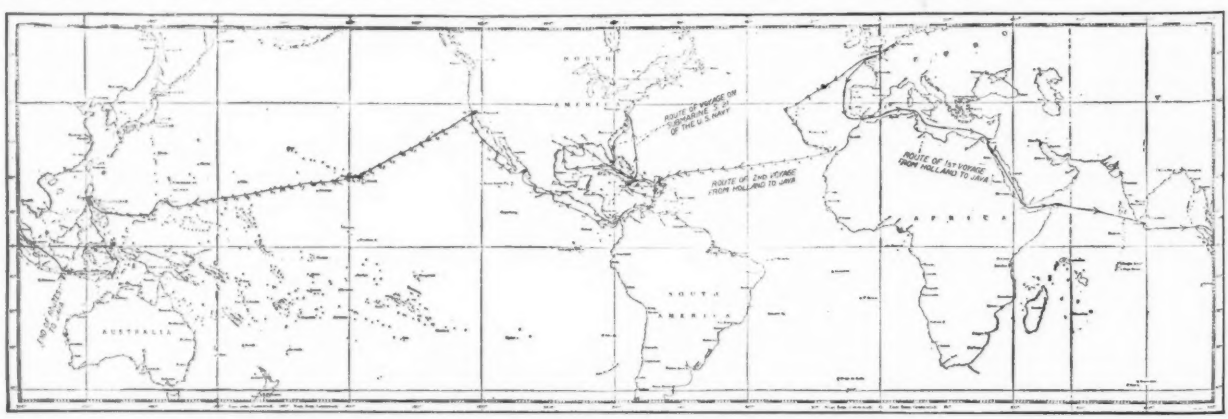
The earth's surface is not fixed for all time. This we know from the sedimentary rocks on the mountain slopes and on the plateaus, thousands of feet above the sea, which contain the fossil remains of sea animals. What caused the uplift is one of the greatest problems of geology.

A few decades ago we had scant data concerning the earth, and consequently hypotheses advanced to account for what was observed at the surface had to be based largely on speculation. We know more now, but still not enough. From collected tidal, seismological, and variation-of-latitude data the definite conclusion has been reached that the earth is solid throughout with a rigidity equal to that of steel; or that, if solid for only a part of the way from the surface, the outer part must be even more rigid than steel.

However, the forces studied, from which the data regarding the interior were derived, act for short times. A body may resist deformation when a force is applied for a short time, but it may act as though it were plastic to the same or a smaller force which is long continued. The sum of the mutual attractions of the particles of matter composing the earth is so vast that no known substance in a mass equal to that of the earth could maintain any other than a globular form. This is the reason for the approximately round shape of the earth's surface. But is the earth strong enough to maintain the continental masses as extra loads, and can it resist the bulging up of the ocean floors because of the deficiency of mass above them? The answer to these questions is that the irregular surface of the earth is caused by the differences in density underlying the different parts of the surface. The differences in elevation do not cause great strains in the earth's materials.

THE investigations carried on by members of the United States Coast and Geodetic Survey have shown that the outer material of the earth under continents, down to a depth of about 60 miles below sea level, has densities depending on the elevation of the surface. The smallest density is under the highest mountains and the greatest density below the coastal planes. By inference it was decided that the density of the material below the ocean should be still greater.

The data used in these investigations were collected on continental areas and on a few ocean islands. The most important data used were values of the earth's attraction, or gravity. If the earth were a perfect sphere and were not rotating, gravity would be the same at all places. If its surface were



ROUTES OF THE THREE IMPORTANT VOYAGES OF THE MEINESZ APPARATUS

The first voyage was taken in 1923, from Holland to Java, on a Dutch submarine; the second was westward from Holland to Java, also on a Dutch submarine; the latest was in the West Indies on a submarine made available to science by Secretary Wilbur

in the form of a spheroid, or a distorted sphere, due to the rotation, gravity would gradually and regularly increase from the equator to the poles.

The water surface of the oceans is very nearly a spheroid, but the solid surface departs considerably from the spheroidal shape. Therefore, gravity should follow very closely the law of change which applies to the ideal earth. The differences are caused by several factors. The value of gravity decreases with the height of the station above sea level. We know the law of this change and can apply corrections. Then it would seem that the attractive effect of the continental and island masses should be determined and applied as corrections. Also the deficiency of mass in the ocean waters should be taken into account. All of this has been done, but there remained large differences between the observed and the theoretical values.

THE next step was to assume that the continents were held at high altitudes because the earth's materials under them are light, just as the ice of the lower part of an iceberg holds the top of the berg out of the water. It was also assumed that the bottoms of the oceans were underlaid by material heavy enough to hold down the ocean basins.

Computations, based on this theory, were made which showed that the assumptions are substantially true, and that these light and heavy materials extend to a depth of about 60 miles below sea level. This condition of equilibrium is called *isostasy*. Dr. Meinesz' gravity work at sea is designed primarily to test the isostatic condition of the earth's crust under the oceans. His data will also be used to make a better determination of the shape of the sea level surface of the earth, that is, the earth's "figure."

DR. F. A. VENING MEINESZ

With his gravity apparatus at the United States Coast and Geodetic Survey

SECRETARY WILBUR GREETS DR. MEINESZ

On the deck of the U. S. Submarine *S-21*, just before sailing from Washington, D. C., for the Gulf of Mexico and the Caribbean Sea for gravity work, as described in the text

The results of his observations lead us to the conclusion that the isostatic condition exists under the oceans to about the same degree that it does under continents. We may now assert that the earth's crust is in isostatic equilibrium. It would remain so were it not for disturbing influences, the most important of which is the erosion of material from land areas, and its transportation by streams and rivers to the margins of oceans and inland seas, where it is deposited in vast quantities. This transfer disturbs the equilibrium. The crust sinks down under the sediments and it rises up under the areas of erosion. In order that this may be, the sub-crustal material must be plastic to forces acting for hundreds or thousands of years. This must be so since isostatic equilibrium exists.

THE gravity data enable us to determine by an indirect method the difference in weight or mass of one part of the earth's crust as compared with other parts. We do not especially care to know how much mass there is in any particular prism of the earth's crust or the density of the rock at different depths. But we do want to know whether one unit prism is heavier or lighter than some other one. When this information is obtained we can then draw more accurate conclusions regarding the cause or causes of the irregular surface of the earth.

The first voyage of Dr. Meinesz on a submarine gave us gravity values on the Atlantic, the Mediterranean Sea, and the Indian Ocean, and showed that the isostatic equilibrium exists under the places at which he made his observations. His other voyages furnished data which proved that the crust under the mid-Atlantic and the great water area of the Pacific is composed of heavier materials than exist in the crust under continents.

DR. MEINESZ has already observed at about 250 places, thus making it possible to show that the ocean basins are depressed by the greater density of the crustal material underneath them. His contribution to the earth sciences is inestimable.

However, his gravity observations obtained on the Dutch submarine were made at widely separated points and mostly in what may be called open waters. There are needed many stations closely spaced in certain critical areas, such as that represented by the West Indies. It was for this reason that Dr. Meinesz was invited to come to this country to work in that region on an American submarine. The data obtained on this expedition are not in final form at the time of writing this paper, but they will surely show much regarding the densities of the crust under the West Indian region, and the degree to which isostasy exists there.

Since it has been found, by extensive gravity determinations at sea in different parts of the ocean areas, that isostasy is a universal condition of the earth's crust, the students of the earth will have to modify or abandon many of the generally accepted conceptions as to the causes of earthquakes and volcanoes, the formation of mountains and plateaus, and the origin of the continents and ocean basins.

How I Built My Glider

An Amateur Tells of His Successful Experiment in Constructing and Flying a Glider

By EDMUND JAMES

As far back as I can remember I have always been intensely interested in flying, but for economic reasons and having been a country yokel far from the centers of learning where aviation was making history, it remained but a dream. I can look back, even now, and see the old Wright flying machine as it circled the Fair Grounds at our County Fair and thrill clear to my toes. But dreams are dreams and it takes a long time for some to come true.

With the impetus that Lindbergh gave to flying, and the various succeeding oceanic flights, my dreams again came to the front, but lack of necessary funds made it seem out of the question. Just about that time the *Literary Digest* re-printed an article from the SCIENTIFIC AMERICAN on the soaring flights of the German gliders, and so was born the idea of building a glider.

With the idea came difficulties. How should I begin? Where could I secure the necessary blue prints and instructions? It was some search. First I went to the library and was informed that they didn't even know what a glider was, much less have data pertaining to its construction. However, they did have books on aviation, and Page's "Aeroplane Construction" proved a great help. Quarters and half dollars to various magazine advertisements brought back the usual run of sucker literature, all generalities; for additional dimes and quarters, more generalities. Finally the search ended with the acquaintance of a Mr. Formvaldt who, through German translations and other data he had accumulated, made up an excellent set of plans and building detail, and so I began.

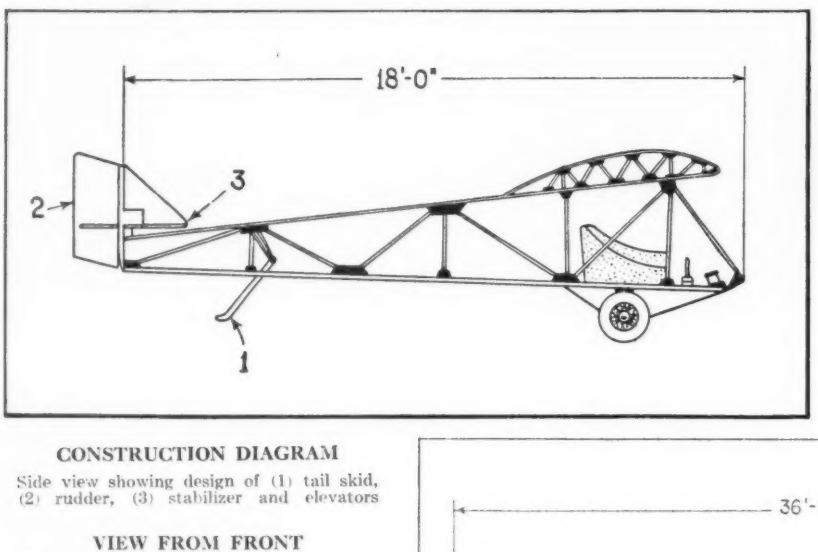
Gathering materials proved to be quite a task and inexperience considerably increased the cost. The purpose of this article is to keep some of the other boys who are interested in building gliders on the straight and narrow path of dollars and sense.

READY FOR THE TAKE-OFF

It proved easier to take-off and fly than to land safely. The wheels made it difficult to stop on a slope

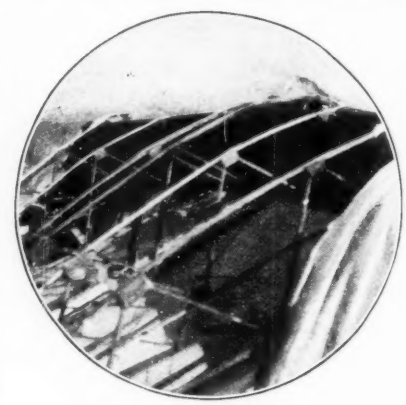
CLEAR spruce is expensive and almost unobtainable in the sizes used, although much to be preferred. Soft pine is the most suitable substitute; both from structural strength and workability it proves very satisfactory. Ash was used for the front end of the fuselage, splicing just to the rear of the pilot's seat.

On just what part to begin is up to the builder. I chose the wings. I took a board six feet long by 12 inches wide and with ¼ x ¼ pine made a rib jig on a pattern of wing similar to that used on the Junkers plane but with more sweep to the tail, giving the wing a cord of five feet six inches. Then to the task of making 36 ribs. Radio packing cases were secured from the radio



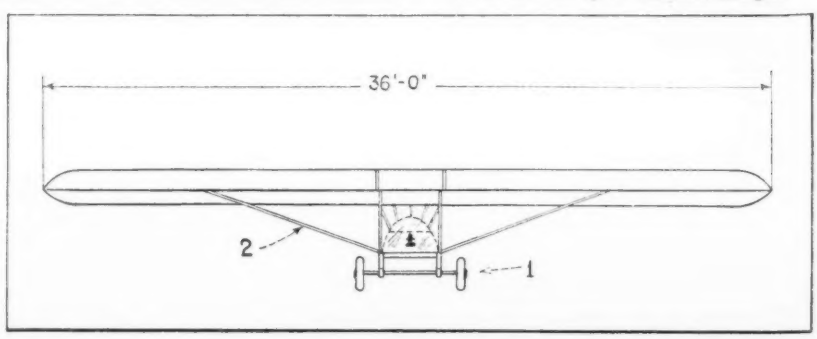
CONSTRUCTION DIAGRAM

Side view showing design of (1) tail skid, (2) rudder, (3) stabilizer and elevators



WING STRUCTURE

The ribs were spaced a foot apart and fastened to the spars with nails and glue



VIEW FROM FRONT

This line drawing shows the position of (1) wheels, axle, and undercarriage; (2) struts

dealers who are usually glad to get rid of them, and were used for the plywood gussets which secured all joints on both sides, being glued and nailed.

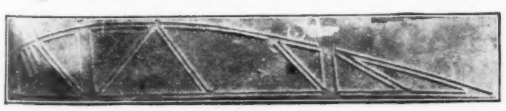
After the wing ribs were made came the fashioning of the wing spars. Each was 18 feet long, ⅛ of an inch in thickness and tapered from a depth of eight inches near the fuselage to two inches at the ends. The use of a solid spar was a mistake as it made the glider too heavy for use on calm days. German box type construction would have saved many pounds but I learned of this only after the wings were made. The spars were laid across a couple of horses and ribs spaced a foot apart were slipped on and fastened with nails and glue. Cross wires were used as internal braces, with sheet metal fittings made from 16 gage sheet metal.

THE COMPLETED GLIDER

Wing and fuselage can be easily assembled after being taken to the field

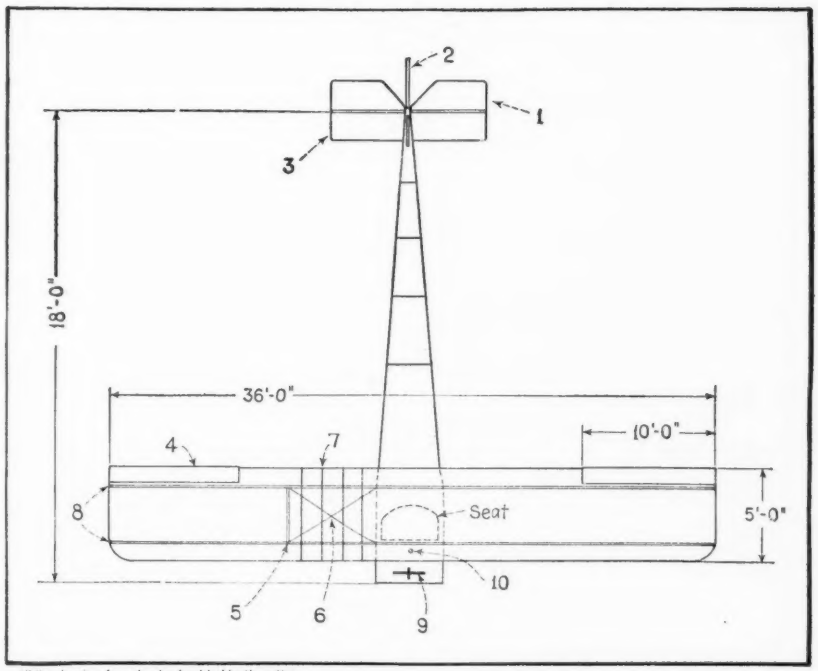
Bicycle spokes were fashioned into turn buckles and worked nicely. The compression struts were made from ⅛ x ⅛ pine and were located between every fifth rib. The trailing edge was inserted with ¼ x ¾ pine and the wings were now ready for covering. The fuselage came next and was made of ⅛ x ⅛ pine and ash of bridge truss construction 18 feet long and ending in a vertical wedge on which was mounted the tail assembly of rudder elevator and stabilizer. The ailerons were assembled from the end of the wing ribs for 10 feet on the outer end of each wing.

After each of the separate parts was made it was assembled in the skeleton and the metal fittings were made for attaching wings and tail assembly to the fuselage, struts, et cetera. Each piece was patterned with paper much as a dressmaker would fit a form and then cut from the metal. Care was taken to build in such a way as to facilitate dismantling and assembling. Both wings and fuselage were so arranged as to be loaded on to a Ford



THE RIB JIG

This model was laid out on a board 10 inches wide and six feet long



All line drawings from sketches furnished by the author

SPECIFICATIONS FOR THE HOME MADE GLIDER

Diagrammatic sketch of Edmund James' glider, showing design and position of (1) elevator; (2) rudder; (3) stabilizer; (4) ailerons; (5) compression struts; (6) internal guy wires with bicycle-spoke turn buckles; (7) ribs; (8) spars; (9) rudder bar; (10) stick, movable four directions for ailerons and elevators. The covering is given three coats of airplane "dope"

touring car for quick transportation from home to the field, and can be completely assembled in thirty minutes. Incidentally, all the metal for fittings was salvaged from a junk pile.

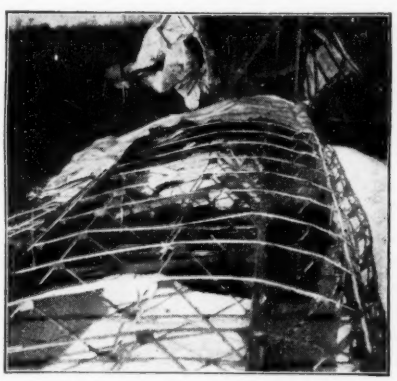
Ordinary sheeting of an inexpensive grade was used for covering and proved to be the easiest part of the work, or my added enthusiasm at seeing it near completion made it seem so. It was then given three coats of airplane dope. Then came the great day.

IT is seldom one achieves success with his first attempt. This was especially true in my case since construction of this kind was strictly out of my line; but with the second attempt it raised majestically to a height of 25 feet and sailed gently down the slope for 150 feet. If I had had the wings of a horse fly I could not have been more pleased, but further analysis in actual practice proved many glaring errors. It was much too heavily constructed and could be made much lighter without in any way sacrificing strength or flying ability.

In order to facilitate the take off, which was accomplished by towing with an automobile, wheels were substituted for the skiis. This is not considered good practice however, as was proved by its wrecking in a clump of trees through inability to stop quickly enough after landing on a down grade.

Gee, but it was great sport though, while it lasted, and quite inexpensive if one forgets the two months of patient labor.

I have laid down the keel of a new



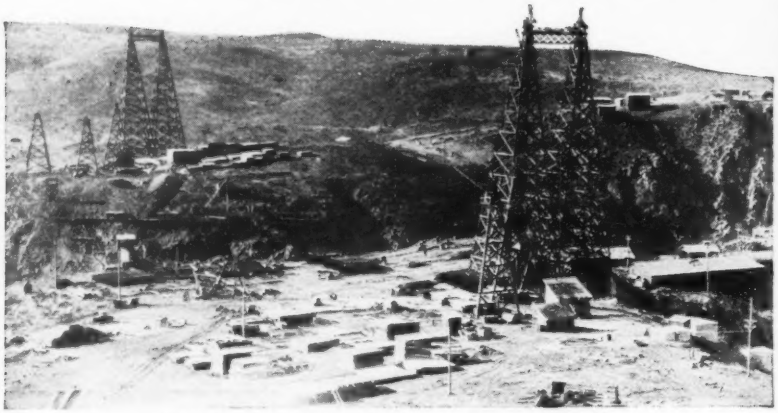
FRAMEWORK OF THE WING

This view, taken after the wreck, shows the structural design of the wing

one of much better design, thanks to Mr. Formvaldt. It won't be long now!

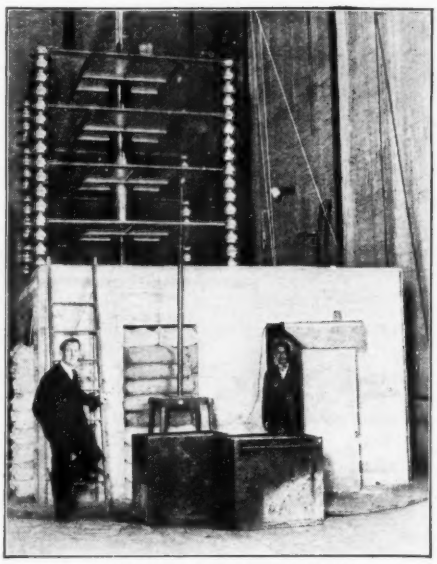
¶ *The foregoing article is presented to our readers with but little editing. In its own way it reflects the enthusiasm of the aeronautical novice, and shows what can be accomplished by even the tyro when the urge is strong. While Mr. James has given only the outline of his work, and but few of the details, we feel that the essence of the subject has been conveyed, and that others can follow in his footsteps.*

Camera Shots of Scientific Events



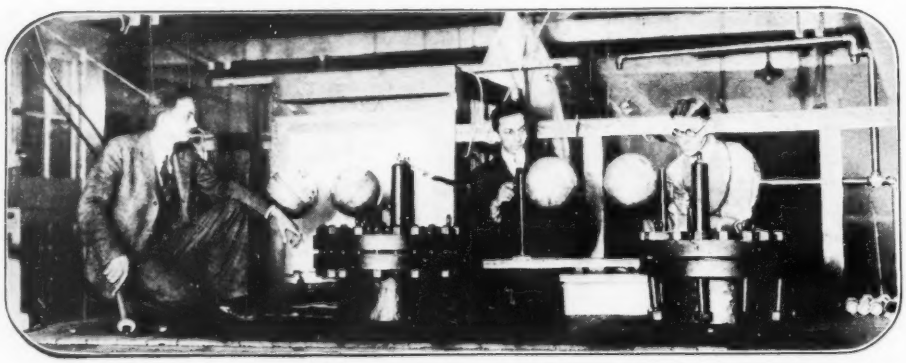
FOR IRRIGATING THOUSANDS OF ACRES

What is said to be the most important agricultural enterprise in Mexico has just been started in Lower California, 14 miles south of the International border. It is a dam for impounding sufficient water to irrigate 50,000 acres of land. The dam will cost 4,000,000 dollars, will be 230 feet high and half a mile long, with an elbow bend in the center. The photograph shows the equipment being set up preparatory to the beginning of construction work



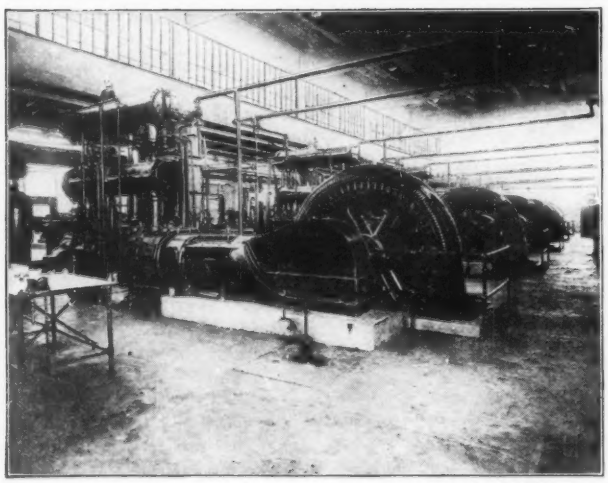
SAND-BAG PROTECTION

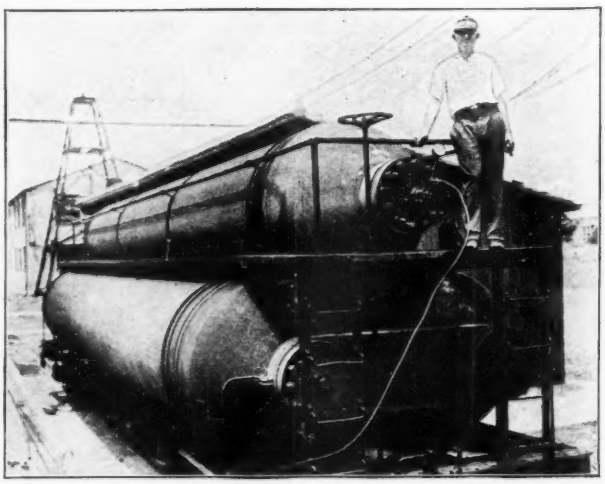
The world's largest X-ray tube at the California Institute of Technology, Pasadena, emits stray rays that would be harmful to scientists operating it, so it has been shielded by a heavy emplacement of sand-bags. Beside the 15-foot tube are Professors C. C. Lauritson and E. C. Watson



SMASHING ATOMS

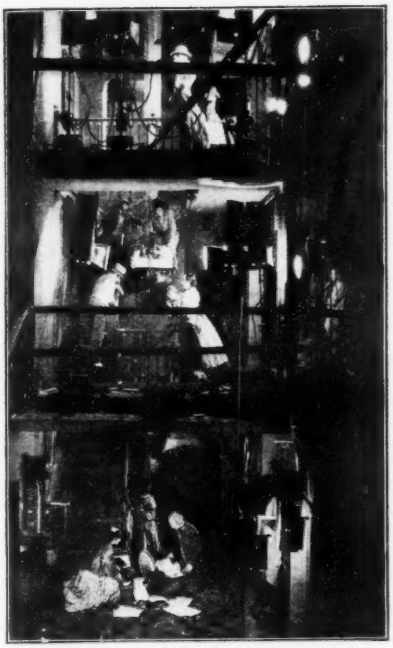
Dr. M. A. Tuve, Dr. Gaviola, and Mr. Hafstead, scientists of the Department of Terrestrial Magnetism of the Carnegie Institution, Washington, D.C., beside the 5,000,000-volt equipment developed for the study of atomic structure. With it they have produced the highest voltage ever obtained—5,200,000 volts. The instruments, including condenser, spark gap, and measuring gap are shown in this photograph





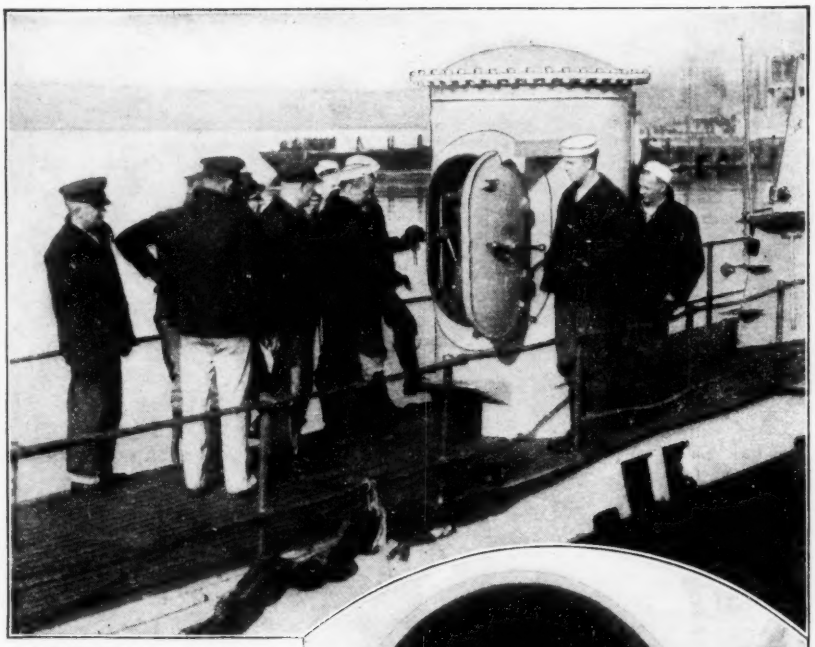
HE' IUM PRODUCTION AND TRANSPORTATION

At the left are shown some of the r ghty compressors at the Federal Helium Production Plant in the natural gas fields near Forth Worth, Texas. These pumps are required to exert a pressure of as high as 3000 pounds per square inch in recovering this rare gas from natural gases. At the right is a specially designed tank car used for transporting helium to naval airship stations. It carries 200,000 cubic feet of gas at a pressure of 2000 pounds and weighs 100 tons



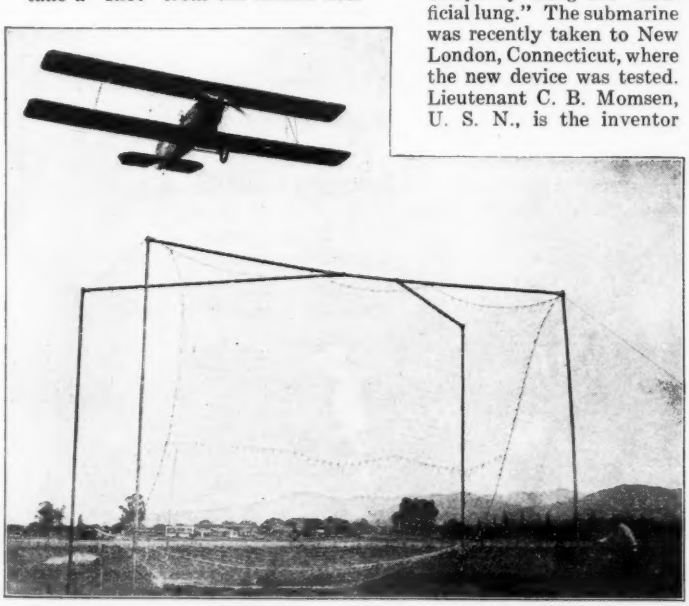
THREE-FLOOR "MOVIE" SET

Metro-Goldwyn-Mayer built this set for a scene in "The Actress." With it, a "shot" may be taken to show what is going on in the stair well of three floors. The director and cameraman may be seen preparing to take a "shot" from the second floor



"ARTIFICIAL LUNG" ➔

The re-conditioned submarine *S-4*, which was rammed and sunk in December, 1927, showing the escape hatch from which members of the crew may escape by using the "artificial lung." The submarine was recently taken to New London, Connecticut, where the new device was tested. Lieutenant C. B. Momsen, U. S. N., is the inventor



AIR MAIL DELIVERY

Tests of a new device for delivery of air mail while the airplane is in flight, invented by Bolton Jones and M. G. Burnham of Whittier, California, have been made and the device is said to have proved successful. A mail bag is let down on a rope where it dangles until it makes contact with sharp blades on the framework of the apparatus. These blades cut the rope; the bag drops into the net, and it may then be retrieved by members of the ground force. This apparatus has no provisions for taking on mail

AT KITTY HAWK ➔

Orville Wright, Senator Hiram Bingham of Connecticut, and Miss Amelia Earhart on the sands at Kitty Hawk, North Carolina, beside the tablet commemorating the first air flight made there 25 years ago by Orville Wright. The tablet was unveiled recently when persons prominent in aviation made a pilgrimage to this scene of the Wright brothers' early experiments

THE PICK-UP SYSTEM IN ACTION

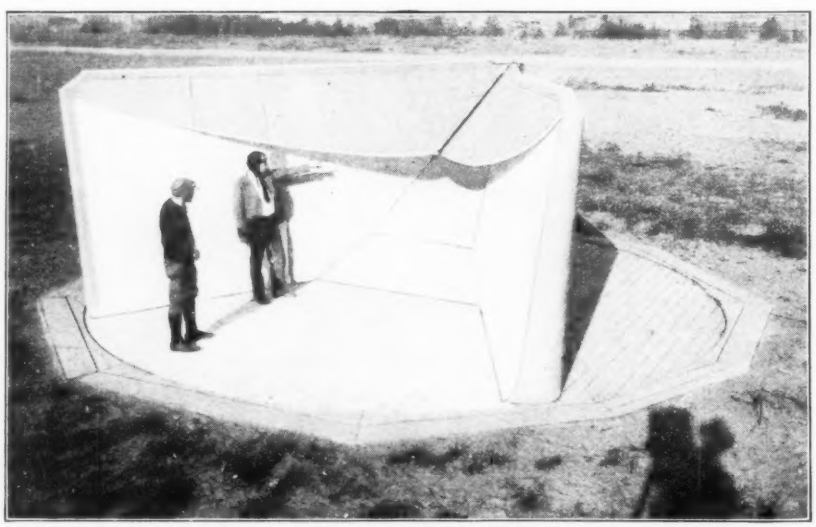
This view gives an excellent idea of the operation of the air-mail pick-up system described below. Notice the cable suspended from the plane, the released thimble, and the package thrown forward from the trap by the catapult

Air-Mail Pick Up and Release

The First Detailed Description of a Device Which May Become a Vital Factor in Speeding Up Aerial Transportation

EVER since the early days of the air mail and aerial transportation of freight and express, one of the drawbacks to increased speed has been the necessity of landing every time the plane has something to deliver or pick up. Such landings make it necessary to lengthen schedules far beyond the actual flying time between terminals and therefore tend to reduce one of the greatest advantages of aerial transportation—time saving. Consequently, the attention of inventors has been drawn to devices which will permit loading and unloading the plane while in flight. One of these, invented by Dr. Lytle S. Adams, of Seattle, Washington, was mentioned in our "Learning to Use Our Wings" department in the November, 1928, issue, and the details of it have just been made available.

A CAREFUL study of the illustrations on these two pages and of the following description will make plain the operation of this clever system. The equipment on the airplane includes a long, thin cable wound on a suitable drum and provided with a ball of special construction on the free end. On the ground is a peculiarly shaped structure such as illustrated on this page. Reference to these photographs will show that the top of this structure or trap slopes toward the center, where there is a long slot. See also Figures 1 and 2. When the cable with the ball on the end is lowered from the plane, the pilot maneuvers so that the ball, assisted by the curved sides of the trap, enters the slot. The ball then travels to the end of the slot where a slotted thimble has been fitted, and in which is a hole so small that the ball cannot pass through. Attached to this thimble, (see Figure 1) is the bag, sack, or other



THE SLOTTED BALL TRAP

This small demonstration model was mounted on a turntable in just the same way as will be the larger traps for regular air-mail use, the dimensions of which are given in Figure 6

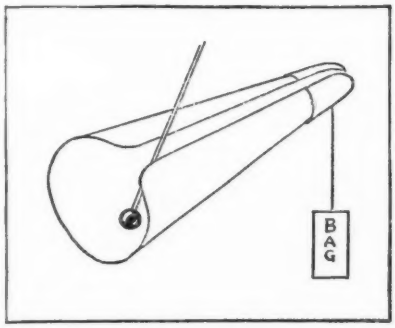


FIGURE 1

A simplified sketch, showing the slot, the ball, the thimble, and bag to be picked up

package to be picked up. The ball pulls the thimble from the end of the slot, a catapult (see Figure 4) throws the bag forward at a predetermined speed, and the plane flies on with its load. The cable is then wound up on the power-operated drum and the bag brought into the plane through a trap door.

Of course, all precautions are taken to prevent accidents. A friction clutch on the drum allows slippage in case of

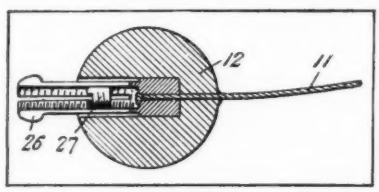


FIGURE 3

A cross-section of the ball, showing at 26 the removable section under spring-tension

a slight entanglement, and the cable is of such size that it will break if too great a load is imposed upon it.

With this system, it is possible to deliver and pick up at the same time. The ball (see Figure 3) is provided with a removable section 26 held in place by spring friction. To this is attached a thimble and to the thimble is fastened the package to be delivered. The pilot maneuvers as described and the ball and package enters the trap. At the end of the slot, the restriction is too great for the thimble to pass through, so the rear portion of the ball is pulled out, leaving the delivered package. The rest of the ball goes on and picks up the other thimble and the waiting package. This is shown plainly in *C* Figure 4.

In Figure 5 are given the details of the catapult, which can be adjusted to handle packages weighing from 50 to

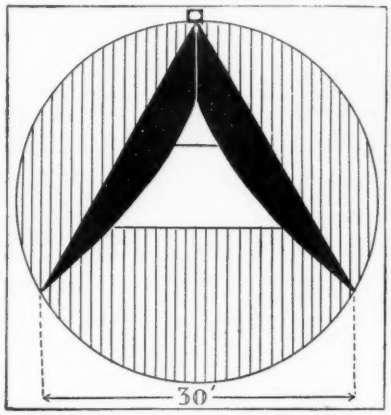
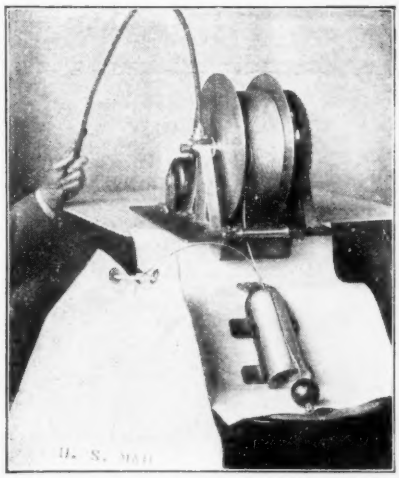


FIGURE 2

Top view of the ball trap. The turntable, the slot, and the curved edges are shown



CABLE REEL

In foreground are the thimble and the ball. A mail bag is shown fastened to the thimble

200 pounds. The package is thrown forward automatically as the ball on the cable picks up the thimble. This places less strain on the cable. In Figure 6 is a simplified diagram of the entire ground part of the system, together with the main dimensions.

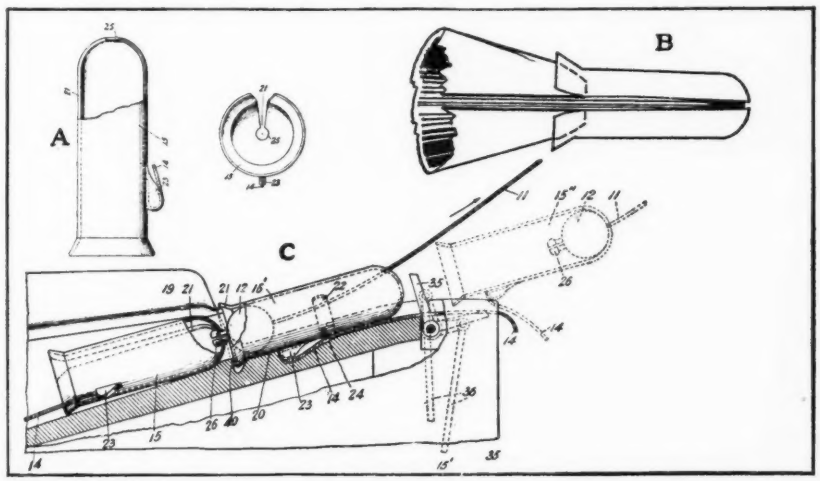


FIGURE 4

At *A* are shown two views of the thimbles. At *B* is a close-up view of one of them in position. At *C* is shown how the delivery and pick up methods work consecutively

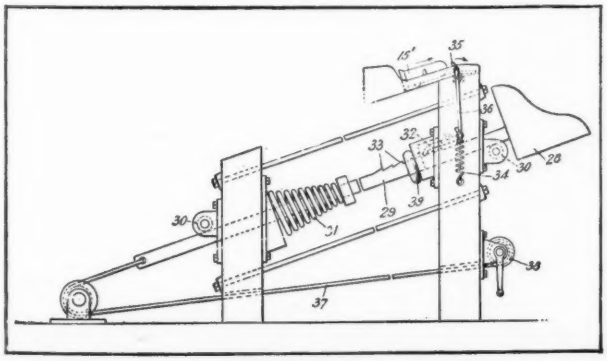


FIGURE 5

The catapult used in connection with picking up packages. As the thimble is released, a trigger is tripped and the catapult operates

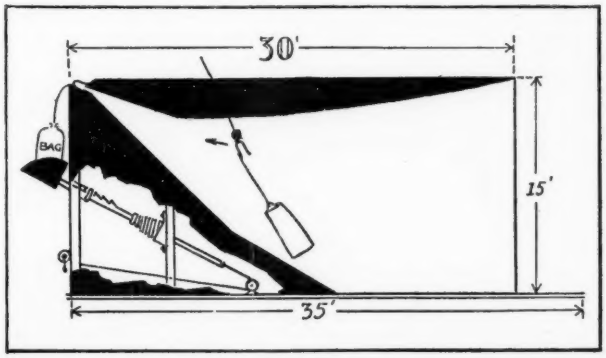


FIGURE 6

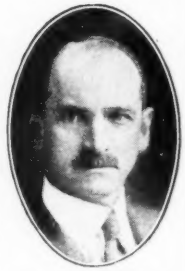
A cross-section of a ball trap, showing in simplified form the location of the various parts of the aerial delivery and pick up system

Pioneers of the Air

ORVILLE WRIGHT

UNTIL the end of time every plane that flies will be a winged tribute to the name of Wright. When Wilbur and Orville, brothers, wheeled their flying machine out upon the sands at Kitty Hawk, North Carolina, and with Orville sitting on the lower wing of the biplane, the craft soared into the air, they opened a new era—the era of man's domination of the air.

In the 25 years since then, we have gone far. From the experiments of the two proprietors of the little bicycle shop in Dayton, Ohio, has grown a mighty industry rich in romance, rich in scientific accomplishment, and freighted with tremendous possibilities for commercial expansion. In the development, the Wrights—at first the two of them, and later, when Wilbur died, Orville alone—have played a dominant role. Today a great organization—The Wright Aeronautical Corporation—manufacturing motors for airplanes bears their name, and Orville Wright's influence is felt throughout the flying world.



GLENN H. CURTISS

Of all living men, Glenn H. Curtiss, alone, is second to Orville Wright in his work in developing the science and industry of aviation. He it was who designed the motor for the first dirigible accepted by the American government; he directed the experiments of the famous Aerial Experiment Association at Hammondsport, New York, where he made the first pre-announced flight in the United States winning the SCIENTIFIC AMERICAN trophy in 1908. With the many types of aeronautical motors he designed and developed, the whole world is familiar. Like the Wrights, his name is borne by a great manufacturing organization, The Curtiss Aeroplane and Motor Corporation, of which he is chairman of the Board of Trustees.

Builders of the Aviation Industry

Back of the Flyers Are the Men Who Are Making of Aeronautics a Giant Industry

By MILTON WRIGHT

DRAMATIC and tremendous impetus was given to aviation by the World War. We shuddered at news of the raids made by the Zeppelins and we were thrilled at the exploits of the Lafayette Escadrille, of Thaw and Rickenbacker and others.

With the end of the War, the development of aviation continued. Alcock and Brown flew across the Atlantic. With increasing frequency, one splendid adventurer after another claimed the attention of the public. Navy planes circled the globe; Byrd crossed the North Pole; and Lindbergh hopped from New York to Paris.

Behind the exploits of these heroes of the air, however, are men who make spectacular achievements possible—men who are so developing the industry and business of aviation that our times will go down in history as the age of man's complete conquest of the air. To learn a little about some of these dominant figures will be well worth while.

A. H. G. Fokker

ANTHONY Herman Gerard Fokker was born in 1890 of Dutch parents on the island of Java. When the boy was six, the father retired with his family to Haarlem, Holland, where the future aircraft designer grew up. As a child, Anthony followed the early experiments of the Wright Brothers and the French inventors, and constructed perfect model planes.

In 1911, he made his first real airplane, almost entirely with his own hands, and taught himself to fly. With this plane he won the Russian Military Competition at St. Petersburg in 1912. This and other demonstrations brought him a number of orders, and in spite of technical and financial difficulties, he began the manufacture of airplanes.

In 1912, one of Fokker's planes made a remarkable flight from Berlin to the Hague. The German Government became interested in him but his own government gave him no encouragement. The English Government likewise turned him down. Then the German Government made a three-year contract with him for the instruction of military pupils and a school was established at Schwerin.

The World War came and the business developed enormously. As the exploits of the German flyers grew in number and audacity, the fame of Fokker grew. In this period he invented a synchronizing gear, making it possible to shoot a machine gun between revolving propeller blades; he manufactured 42,000 of these for the German armies.

A. H. G. FOKKER

With the Armistice, Fokker moved to Holland and established at Amsterdam the Netherlands Aircraft Manufacturing Company. This company has made and sold more than 10,000 planes, produced 53 different types and made customers of governmental and commercial organizations in 25 countries.

Believing the greatest possibilities of commercial development to lie in America, Fokker, co-operating with a group of American business men, formed the Atlantic Aircraft Corporation at Teterboro Airport, Hasbrouck Heights, New Jersey, in December, 1923. Three years later the Fokker Aircraft Corporation was formed, absorbing the Atlantic corporation and establishing a new factory at Glendale, West Virginia. Late last year affiliations were made with a number of important air transport operators.

Sherman Mills Fairchild

SURVEYING, map-making, and photography from the air are no small part of the benefits of aviation. The man responsible for their development is Sherman Mills Fairchild.

Fairchild is an engineer. After his graduation first from the University of Arizona and later from the Colum-

bia University School of Engineering, he did considerable experimenting with aerial photography, eventually producing a camera which had several new features. The large camera manufacturers, however, were unable to solve satisfactorily the problem of making the roll of film feed the same amount for each picture. It was an important matter for the United States Government, and Fairchild received a telegram from Washington asking him to go to Rochester and spend a day in the factory studying the problem. He went.

On the train that night he invented a mechanism which eliminated all the difficulty. As soon afterwards as drawings could be made incorporating his idea, they were sent to Rochester, and the manufacture of his device was started. The bit of concentration on a railway train was the first of a series of steps which has led directly to the adoption by the American Government, the Canadian Government, and the Government of Brazil, of the Fairchild Aerial Camera.

For aerial camera work it is necessary that the airplanes used be sturdy, powerful, and reliable at all altitudes and all temperatures. To meet these needs, the Fairchild cabin plane was designed. When it appeared there arose a general demand for it and the Fairchild Airplane Manufacturing Company was formed in 1926. Its production has increased steadily as its reputation has spread, and the organization has developed rapidly.

A hint of the extent of the Fairchild activities may be gleaned from the names of the companies now grouped together. They include the Fairchild Aerial Camera Corporation; Fairchild Aerial Surveys, Inc.; Fairchild Caminez Engine Corporation; Fairchild Airplane Manufacturing Corporation; Fairchild Aviation Limited,

© Bruno and Blythe
SHERMAN MILLS FAIRCHILD

Canada; Fairchild Air Transport Limited, Canada; Compania Mexicana de Aviacion, Mexico; and, dominating them all, the Fairchild Aviation Corporation.

Harry F. Guggenheim

WHEN Daniel F. Guggenheim established the Fund for the Promotion of Aeronautics in January, 1926, his son, Harry F. Guggenheim, became its president and a trustee of the Fund.

By training as well as by inheritance he is eminently fitted for the task. Schooled at Yale and at Cambridge, England, and trained in mining and metallurgy, he had been active in the development and management of mining properties as a member of the firm of Guggenheim Brothers. In the World War he served as a naval aviator in the Foreign Service of the American air forces in France, England, and Italy. With his relief from duty on December 21, 1918, commissioned as a lieutenant commander, his interest in aviation was definitely assured.

Under Mr. Guggenheim's direction, the Fund has divided its work into four categories: (1) academic instruction, (2) scientific research, (3) commercial development, and (4) public

HARRY F. GUGGENHEIM

education. The first two objectives are represented in the Fund's gifts of more than 1,200,000 dollars to five large engineering universities to establish aeronautical laboratories.

To stimulate passenger carrying by air, the Fund has granted a loan to an air transport company to establish the first adequate passenger service in the United States. Over the route of this company, between Los Angeles and San Francisco, the Fund has helped to finance a complete weather reporting service.

Last May the Fund announced that it would concentrate its future efforts upon research and experimental work of a basic nature. In following out this policy, a full-flight laboratory has been established under the direction of Lieutenant James H. Doolittle, where the actual operation of aircraft in fog with the use of the many devices perfected for fog flying is part of the research. Another step was the inauguration of the Safe Aircraft Competition, offering prizes totaling 150,000 dollars for the airplane which should represent, in accordance with specifications laid down, the greatest advance in safety without sacrificing efficiency. The Fund also is financing the development of safety devices and

Harris and Ewing
IGOR I. SIKORSKY

navigation instruments by grants to societies and institutions engaged in such experimentation and has undertaken a nation-wide campaign for the identification of towns and cities.

Igor I. Sikorsky

FIVE years after the Wright brothers flew their plane at Kitty Hawk, a 19-year-old Russian, Igor I. Sikorsky, began a distinguished career by building a helicopter at Kieff. Within the next two years he had built three airplanes and by 1911 he reached an altitude of 1500 feet and remained aloft for an hour. The next year he took the highest award at the Moscow Aviation Exhibition and won a prize at the St. Petersburg Military Competition against the leading manufacturers of Europe.

The following year Sikorsky constructed the first successful multi-motored airplane. In more than 50 flights he proved conclusively the soundness of the multi-motored principle. Aviation developed rapidly, but not too rapidly for Sikorsky to keep pace.

Russia used 73 giant Sikorsky airplanes in the World War. All but one returned victorious. It is said that in many respects these machines were more succesful than the machines of any other country.

With the outbreak of the Russian Revolution, Sikorsky entered the service of France. With the signing of the Armistice, he came to the United States and became an American citizen.

The Sikorsky reputation was such that in 1923 it was possible to form the Sikorsky Aero Engineering Corporation. In 1925 the business of this company was acquired by the Sikorsky Manufacturing Corporation, of

which the inventor was president. Several highly successful types of airplanes were evolved, and the corporation moved to a larger plant at College Point, Long Island.

Recently the business has been reorganized as the Sikorsky Aviation

DR. KARL ARNSTEIN

Corporation for operation on a greater scale than ever before, in conjunction with the Curtiss Flying Service, Inc., and the Curtiss Export Association, which will direct its sales.

Dr. Karl Arnstein

THE relative merits of heavier-than-air craft and lighter-than-air craft may be subject to spirited controversy, but of the fact that a man who dominates the lighter-than-air industry in this country belongs in any group of aviation's leaders there can be no dispute. Such a man is Dr. Karl Arnstein, vice president and chief engineer of the Goodyear Zeppelin Corporation, of Akron, Ohio, subsidiary of the Goodyear Tire and Rubber Company.

Dr. Arnstein was born in Prague, Bohemia, 42 years ago, He graduated from the university of his native city, serving in the faculty as assistant professor before he received his degree of doctor of technical sciences. It was not long before the young engineer was enjoying a wide reputation for his technique in stress analysis, and he was invited to join the growing organization of airship engineers on Lake Bodensee.

In 1914, Dr. Arnstein became chief engineer of the Zeppelin company, devoting his energies principally to the development of fundamental principles in airship design, with especial reference to the stress analysis of rigid airships and metal airplanes. He is responsible for the principal design of about 90 military and commercial airships, including the *Los Angeles*.

When Dr. Arnstein joined Goodyear he at once began the task of designing two military rigid airships of about 6,500,000 cubic feet capacity for the navy. The Navy's Bureau of Aeronautics had inaugurated two competitions and Arnstein set out to win them. He succeeded.

In October 1928, Goodyear was awarded the contract for two ships of this type and Dr. Arnstein has started to direct their construction as well as the erection of a giant airship hangar.

Charles L. Lawrance

AN outstanding development in flying today is the famous Wright Whirlwind motor. The man responsible for it is Charles Lanier Lawrance, pioneer in the development of air-cooled motors for airplanes and president of the Wright Aeronautical Corporation.

Lawrance's interest in motors began in the nineties when he was a student at Groton, although he actually began to tinker with combustion engines only after he entered Yale in 1901.

The young engineer had that rare combination: independent means and a liking for hard work. He went

Marceau

CHARLES L. LAWRANCE

to Paris and for three years studied aerodynamics at the *Ecole des Beaux Arts*. In 1912 he developed an airplane wing section which, when tested at the Eiffel Laboratory, showed remarkable results. Returning to the United States in 1914, he began his first work on an air-cooled motor and organized the Lawrance Aero Engine Company with a working capital of only 17,000 dollars.

The army would have none of Lawrance's motors, but the navy ordered 450 of them for their grass-cutter type of training plane. Then he received an order for air-cooled engines for planes to be carried by submarines. America entered the World War and he was ordered to continue his laboratory researches. His first 200-horsepower engine resulted. It was radial, air-cooled, and much like the present Wright Whirlwind.

In 1923 the navy decided to buy no more water-cooled motors. The Wright corporation, deprived of an important market, found itself faced with the necessity of competing with Lawrance or buying him out. They paid him 500,000 dollars for his designs and patents and induced him to join their organization. The next year he was its president.

Clement Melville Keys

IT was all very well in the early days of aviation for the industry to grow through the efforts of men who were flyers, inventors, engineers, and air enthusiasts, but there came a time when the airplane business required men who were, above everything else, good business men. That time seemed to have arrived in 1916, when the Curtiss Aeroplane and Motor Corporation secured Clement Melville Keys as its vice president.

Keys was then 40 years old. Born in Canada, he had graduated from Toronto University in 1897 with a B. A. degree. He was destined for a career in finance and while still in his thirties became recognized as an investment authority.

A year after he joined the Curtiss organization, Keys added to his titles that of treasurer of the Curtiss Engineering Corporation. In two more years he was a member of the American Aviation Mission and chairman of the Finance Committee of the Curtiss Aeroplane and Motor Corporation. In 1923 he was made president of the corporation, a position he still occupies.

In aviation, as in many other fields, the interests of one kind of company overlap the interests of another, and Keys had broadened his activities to include related activities. He is president of the Trans-Continental Air Transport, the air-rail route between New York and the Pacific Coast. He also is chairman of the Executive Committee of the National Air Trans-

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CLEMENT MELVILLE KEYS

port; senior partner of C. M. Keys and Company, investment brokers; chairman of the board of directors of the Curtiss Export Corporation and the Curtiss Flying Service; president of Glenn H. Curtiss Properties, Inc.; vice-president of Curtiss-Robertson Airplane Manufacturing Company;

and a director in the National Aviation Corporation.

William B. Stout

WILLIAM Bushnell Stout, journalist, teacher, mechanical engineer, and inventor, graduated from the University of Minnesota in 1902. After four years of writing for newspapers, he toured Europe in 1908 in an automobile and when he came back he began to specialize in automotive work. He became chief engineer of the Schurmeier Motor Truck Company, and technical and aviation editor of the *Chicago Daily Tribune*. In 1917 he became chief engineer of the aircraft division of the Packard Motor Car Company and later was appointed technical adviser to the Aircraft Board in Washington.

A few years ago he raised money for an aviation development on one of the most unusual pleas ever advanced by a promoter. He went to a number of leading business men in Detroit and said to each of them in substance: "I want to take 1000 dollars of your money to see if I can develop something in the aviation field. It is a sporting venture. You may never get a cent of it back, but I guarantee you 1000 dollars worth of fun."

Henry Ford became interested in Stout in 1925 and the next year aided him in establishing an air route between Detroit and Grand Rapids, using seven-passenger planes. It was an experimental line, and with the knowledge gained, the Stout Air Service opened another line between Detroit and Cleveland. In two and a half years, 65,000 passengers have been carried. The Ford and Stout interests have recently entered upon an extensive transport program beginning with air service between Detroit and Chicago.

Courtesy *Aero Digest*

WILLIAM B. STOUT

William E. Boeing

WHEN the National City Company of New York, and the Pacific National Company of Seattle, announced through the newspapers last October that they had invested from five to ten million dollars in the Boeing Airplane and Transport Company, investors in the east began to sit up and take notice. The merger was the herald of a nation-wide transcontinental air service between New York and San Francisco, using trimotored Boeing planes.

William Edward Boeing, dominant power in the organization which bears his name, was born in Detroit 47 years ago and graduated from Yale University. His flying instruction he received under Glenn L. Martin. After entering the navy, he became a lieutenant in the United States Naval Reserve Force.

Primarily, however, Boeing's interests have been those of a lumberman; for years he has been prominent in industrial and civic affairs in the northwest.

Aviation, with Boeing, is a hobby which began in 1915. That year he purchased a plane in San Francisco, and flew to Seattle with Commander Westerveldt of the United States Navy. His interest awakened, it was not long before he was re-designing a plane in accordance with his own ideas. He made two planes in his private workshop, and the tinkering grew into a manufacturing business. Today the Boeing factory has the largest payroll of any manufacturing company in Seattle, and, with approximately a thousand employees, is one of the largest airplane producers in the country.

Courtesy *Aero Digest*

WILLIAM E. BOEING

In 1926, Boeing took up a private contract with the Post Office Department to carry the mails for 1000 miles of the western-most leg of the transcontinental air mail. He has since added to his operations air mail and passenger service between Chicago and San Francisco and, through his subsidiary, the Pacific Air Transport, the air mail between Seattle and Los Angeles.

Richard F. Hoyt

RICHARD FARNSWORTH HOYT, A. B., Harvard, 1910, stands out as a man who is putting the aviation industry in the category of big business. His career in aeronautics began in the World War, when he was first civilian assistant to Colonel Vincent at McCook Field. Later he was secretary and assistant to the president of the Wright-Martin Aircraft Corporation. Today as chairman of the board of directors of the Wright Aeronautical Corporation, chairman of the Committee on Aeronautics of the Merchants Association of New York and member of the Advisory Committee of the Transportation and Communication Department of the Chamber of Commerce of the United States, he is a leading financial figure in aircraft affairs.

Marceau

RICHARD F. HOYT

Not long after his wartime service, Hoyt widened his interests and became chairman of the board of directors of the Wright Aeronautical Corporation.

Hoyt's activities have grown with public interest in air travel. He became chairman of the board of directors of the Aviation Corporation of Americas, which, through its subsidiary, the Pan-American Airways, now controls the world's largest system of international air routes. He also became chairman of the board of the Keystone Aircraft Corporation, builders of standard army bombing planes. Recently he was instrumental in effecting a merger between the Loening Aeronautical Engineering Corporation and the Keystone Corporation.

Brigadier General Benjamin D. Foulois

AS brilliant and distinguished a career as any soldier today possesses is that of Benajmin D. Foulois, the first army air pilot in point of service, self-taught in the first army airplane and now a brigadier general, assistant chief of the Air Corps.

While still under the legal age for enlistment, Foulois enlisted as a noncommissioned officer in the volunteer forces in the Spanish-American War. With the close of the war he enlisted in the regular army, and while serving

in the Philippines was commissioned a lieutenant of infantry. His career was an adventurous one, and in 1908 he operated the first dirigible balloon purchased by the government. The following year he was selected as one of three army officers to operate the

Official Photo, U. S. Army Air Corps

BRIG. GEN. B. D. FOULOIS

first military airplane purchased from the Wright brothers. He personally designed the first dirigible tent hangar. In the first cross-country trip made by a flying machine, during which three world records were broken, he was a passenger with Orville Wright. From January, 1910, to March, 1911, he was the only officer in the United States Army on flying duty. In this period, with repeated crashes, he taught himself to fly. The next year he adapted radio to airplane uses, receiving messages over a distance of 18 miles.

By 1915 the Aviation Section of the Signal Corps had grown to considerable size and Foulois, now a captain in command of the First Aero Squadron, operated his force in the co-ordination of artillery fire at Fort Sill, Oklahoma. The first serious consideration of the effectiveness of an air force was impressed upon military men when he moved his command by air 650 miles to San Antonio in five days. His work with the Mexican Punitive Expedition elicited from General Pershing the remark that one airplane was worth a regiment of cavalry to him.

In the World War, after planning the organization of the Air Force, he drafted the first appropriation for it, sailed to France as Chief of the A. E. F. Air Service, built the ground plans, and led the first all-American squadron of American planes and American pilots over the German lines. At the close of the war he served on numerous commissions, including the Supreme War Council.

Guiseppe M. Bellanca

AT a time when every aeronautical engineer was adjusting propellers on the rear ends of airplanes in order to make them push the planes ahead more effectively, one man had the temerity to put the propeller on the front end so that it could *pull* the craft through the air. Today the tractor plane, with the propeller on the bow instead of the stern, is almost universal.

That inventor was Guiseppe M. Bellanca, originator of radical innovations in airplane construction. One day in 1911, when he appeared at the flying field in Mineola with a single-seated parasol monoplane of unusual design and announced he was going to learn to fly it, the experts gave him three days to live. They would have made it three hours only the inventor said he was going to learn gradually by easy stages. Not only did Bellanca not come to grief, but it was not long before he opened the Bellanca Airplane School and taught other flyers, acting himself as a flying instructor from 1912 to 1916.

Bellanca was born at Sciacca, Italy, 43 years ago. He received his education at the Milan Technical School and the Royal Institute of Milan, becoming professor of mathematics in the latter institution in 1910. He had started in aviation in 1907 by writing for French and Italian technical magazines. In 1908 and 1909, with two friends he built a two-seater pusher biplane. It went a hundred feet and crashed, a circumstance which may or may not have had something to do with the fact that Bellanca has become the inventor of a large number of aircraft safety devices.

Bellanca's best known plane is the *Columbia*, which won the distance world's record with the flight of Chamberlin and Levine from New York to Germany. He also is designer of the *Roma*, the large ship built for the

Courtesy *Aero Digest*

GUISEPPE M. BELLANCA

flight from New York to Rome and he now is constructing in the New Castle plant of the Bellanca Aircraft Corporation, of which he is president, a multi-engined plane which he believes is destined to play a leading role in the progress of aviation this year.

Charles H. Colvin

THAT the development of navigation of the air depends upon the development of instruments goes without saying. Here is the field in which reigns Charles H. Colvin, general manager of the Pioneer Instrument Company, surviving member of a triumvirate of air instrument makers.

CHARLES H. COLVIN

In 1913, a year before he received his M.E. degree from Stevens Institute of Technology, Colvin became associated with the Curtiss company. The next year he joined the Sperry Gyroscope Company as a designer of instruments. In 1919, with the late B. H. Goldsborough, he founded the Pioneer Instrument Company, opening a small workshop in New York.

While Goldsborough worked at the bench, Colvin started out to find enough business to keep his partner busy. His first sale was to the United States Government for turn indicators to be placed on the NC flying boats which attempted the navy's first transatlantic flights.

As the business grew the firm moved to larger quarters where they built gages and other instruments. In 1920 they were joined by the late M. M. Titterington and the three became the leading designers in the country. It was they who supplied instruments for the 'round-the-world flyers and for Lieutenant Russell L. Maughan, who made the first dawn-to-dusk transcontinental flight.

The earth inductor compass, employing radically new principles of design, they introduced in 1927. It was this instrument which so materially aided Lindbergh in his flight across the Atlantic that he hit the mark at which he aimed within less than five miles. Following Lindbergh, every trans-oceanic aviator has equipped his plane with the same type of instrument.

Grover C. Loening

THE first degree ever awarded by an educational institution for aeronautical research was given to

Grover C. Loening when he received his master of arts degree at Columbia University. Today, Loening, born in the American Consulate at Bremen, Germany, where his father was United States Consul, is one of the world's leading airplane designers.

In 1911 and 1912, Loening was chief engineer of the Queen Aeroplane Company of New York and the next two years general manager of the Wright company at Dayton. With war in Europe, army authorities in this country began actively to enlarge their aircraft facilities and in 1914 and 1915 Loening occupied the post of chief aeronautical engineer for the United States Army Air Corps.

In 1916 he turned again to manufacturing, being vice president and general manager of the Sturtevant Aeroplane Company of Boston for two years. Then he organized his own company, the Loening Aeronautical Engineering Corporation, recently merged with the Keystone Aircraft Corporation. He also was president in 1923 of the New York-Newport Air Service, Inc.

Loening's achievements in aviation have been of a varied nature. Back in 1911, he built and flew the first flying boat. He also originated the monoplane flying boat, and, at the Wright plant in 1912, the first American short-hull flying boat. In 1914, at San Diego, he invented the first rigid-braced pursuit monoplane and the following year at the same place he built the Signal Corps tractor used by Lieutenant B. I. Jones in establishing the world's three-passenger endurance record and by Lieutenant T. F. Dodd in making the cross-country record.

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GROVER C. LOENING

In 1916, he introduced steel construction in the Sturtevant biplane and in 1917 he began the design and development of the Loening monoplane and the Loening seaplane. In fact, he still is continuing the development of new and original designs for the government.

The Collier Trophy for 1922 was won by Loening for his design and development of the Loening "Air-Yacht." The previous year he had won the

SYLVANUS ALBERT REED

Wright Trophy. In 1923 he designed the world's first single-motor tractor amphibian.

Sylvanus Albert Reed

YOU can count on the fingers of one hand the men over 50 years of age who are accomplishing things in aviation, but there is one man born in 1854—Sylvanus Albert Reed—who is making his mark. His contribution to the industry is the famous Reed metal propeller, with which many outstanding military, naval, and commercial records have been made.

After a career as a mining engineer, Reed retired in 1912 to occupy himself in experimental research in his private laboratory. Engaged in problems of sound, he used apparatus in which vanes rotating from a hub were spun at high speed. He thought he saw an application to aircraft propellers and entered upon a three years' job of experimental research with models, producing in 1921 his first duralumin propeller. It proved successful in public test flights and he then made at his own expense about 50 more for a variety of duties, several being sent abroad for government tests.

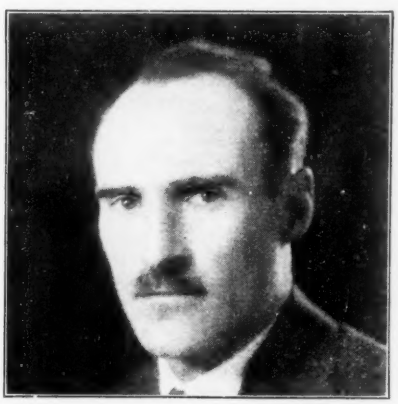
Attracted by his results, the Curtiss company in 1923 entered into a license agreement with him to make and sell his propellers, upon which he had applied for patents in 1920 and 1921. These propellers were used in the planes the Curtiss company was making for the army and navy races in 1923 and for the Schneider and the Pulitzer cup races. Their performance attracted the attention of aircraft people generally. Regular production of the Curtiss-Reed propellers followed and in the next three years most of the new army, navy, and air-mail planes were using them. In 1926, the Collier Trophy was awarded to Reed for his propeller as the most important achievement in aeronautics for the previous year. He now is occupied with experiments to increase the efficiency of 87 percent with which his racing propellers are believed to have operated, as well as to develop special types of propellers for new conditions which may arise.

Charles Sherman Jones

PERHAPS the best known commercial pilot in the country is "Casey" Jones, holder of Transport License Number 13 of the Department of Commerce. He happens to be president of the Curtiss Flying Service, a member of the Technical Committee of the National Air Transport and a director of the Curtiss Aeroplane and Motor Company and of the Curtiss Export Company, but there is a certain "human-ness" about him that tends to make him a familiar person.

Long before Charles Sherman Jones, a Vermont Yankee, graduated from Middlebury College with an A.B. degree, he had been interested in aviation. He had made his first flight in 1911 when a high school classmate bought a machine. In June, 1917, he entered the Army Air Service and after a period of flying instruction in this country and in France, which ended with his being made an officer in charge of flying, he went to the front with the 96th Pursuit Squadron and then became assistant officer in charge of training with the Third Aviation Instruction Center, where all the pursuit training of American troops in France was given.

Back in America again, he joined the Curtiss organization and organized the Curtiss Exhibition Service, later known as the Curtiss Flying Service, and has become famous as a test pilot. He has competed in substantially all



C. S. ("CASEY") JONES

the national air races, starting in 1919 with the New York-Toronto race where he won second place. Since 1921, when he won the American Legion Derby, his string of trophies has lengthened steadily, including two firsts and a second in the 1921 National Air Races, two firsts in 1925, and a first and a second in 1926.

What Things Are Made Of—II

The Paradox of Light; Einstein and the Photoelectric Effect; Peculiar X-Ray Echoes; Photons and Electrons; The Paradox of Particles and Waves

By ARTHUR H. COMPTON, Ph.D.

Professor of Physics, University of Chicago.
Member American Philosophical Society; National Academy of Sciences; National Research Council. Nobel Physics Prize Winner, 1927

(Concluded from February)

THE tangible things with which we are acquainted, rocks and mountains, trees and people, are built of atoms and electrons and protons. In stating the subject of this article, however, the word "things" was chosen because it included an important something which we are apt to overlook. I refer to

ELECTRON TRAILS

Figure 13: Beta particles recoiling from the impact of X-ray particles or "photons"

light and similar radiations such as wireless waves and X rays which may be grouped with light under the term "radiations." What is light?

As long ago as the 17th Century, Newton defended the view that light consists of little particles shot with tremendous speed from a candle or the sun or any other source of light. At the dawn of the 19th Century, however, experiments were performed which gave very direct evidence that light consists of waves. Maxwell interpreted them as electromagnetic waves and in such terms we have ever since been explaining light rays, X rays and radio rays. We have measured the length of the waves, their frequency, and other characteristics and have felt that we know them intimately. Very recently, however, a group of electrical effects of light has been discovered for which the idea of light waves gives no explanation, but whose interpretation is obvious according to a modified form of Newton's old theory of light particles.

The evidence that these radiations consist of waves is so familiar that I shall not take time to outline it. Let me, rather, present some of the reasons why we feel that light consists of corpuscles.

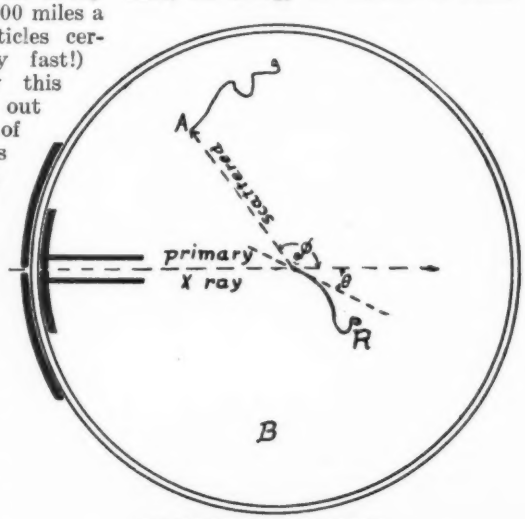
When a beam of light falls upon the surface of certain metals, such as metallic sodium, electricity in the form of electrons is found to be emitted from the surface. This effect is especially prominent with X rays, for these rays eject electrons from all sorts of substances, as was shown for example in Figure 7 (see February issue). X rays are produced when a stream of electrons hits a block of metal inside an X-ray tube. It is as if one were shooting at a steel plate with a rapid fire gun. The stream of bullets represents the electrons and the racket produced when the bullets strike the steel plate corresponds to the X rays emitted at the metal target inside the tube.

LET us suppose that an electron strikes the target of an X-ray tube at a speed of say 100,000 miles a second. (These little particles certainly move tremendously fast!) The X ray produced by this electron may be knocked out of the metal, and the speed of this electron will be almost as great as that of the original electron which gave the rise to the X ray.

The surprising nature of this phenomenon may be illustrated by an experience which I had when camping in my early boyhood. My older brother, with several of the older boys, built a diving pier around the point a half mile away from camp, where the water was deep, while we younger boys built a diving pier of our own in the shallower water near the camp. One hot, July day my brother dived from his diving board into the deep water. By the time the ripples from the splash had gone around the point to where I was swimming a half mile away, they were of course much too small to notice. You can imagine my surprise therefore when these insignificant ripples, striking me as I was swimming under our diving pier, suddenly lifted me bodily from the water and set me on the diving board!

Does this sound impossible? It is no more impossible than for an ether ripple sent out when an electron dives into the target of an X-ray tube, to jerk an electron out of a second piece of metal with a speed equal to that of the first electron.

CONSIDERATIONS of this type showed to Einstein the futility of trying to account for the photoelectric effect on the basis of waves. He suggested, however, that this effect might be explained if light or X rays moved in particles. These particles we now call "photons." The picture of the X-ray experiment on this view would be that when the cathode electron strikes the target of an X-ray tube, its energy of motion is trans-



TRAILING AN X RAY

Figure 14: Photographing two electrons, *R* and *A*, struck by an X ray. See the text

formed into a photon, that is, a particle of X rays which goes with the speed of light to the second piece of metal. Here the photon gives up its energy to one of the electrons of which the metal is composed, and throws it out with an energy of motion equal to that of the first electron.

Thus Einstein was able to account in a very satisfactory way for the phenomenon of the emission of photo-electrons. But his theory had been devised for just this purpose. It was not surprising that it should work well for this one fact. It would naturally carry much greater weight if it could be shown that his theory accounted for other facts for which it had not been originally intended. This is what it has recently done in connection with certain properties of scattered X rays.

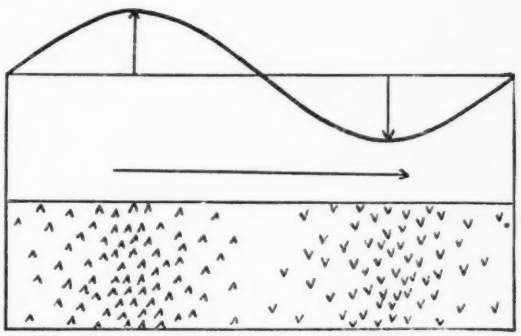
IF you hold your hand in the light of a lamp, your hand scatters light from the lamp into your eyes. This is the way by which your hand is made visible. In the same way, if the lamp were an X-ray tube, your hand would scatter X rays to your eyes. If you had a blue light in the lamp, your hand would appear blue. If the light were yellow, your hand would appear yellow and so on. But some five years ago, we noticed that when one's hand or anything else scatters X rays, the "color" or wavelength of the rays is changed. The corresponding effect with light would be for one's hand to appear green when illuminated with a blue light, to appear yellow when illuminated with green light, red when lighted by a yellow lamp and so on. [This change in wavelength is now known to physicists as the "Compton Effect," after the author of the present article.—Editor.]

If X rays are waves, scattered X rays are like an echo. When one whistles in front of a barn, the echo comes back with the same pitch as the original tone.

DIFFRACTION OF X RAYS

Figure 17: Pattern obtained by passing a pencil of X rays through powdered aluminum crystals (Hull). See Figure 18

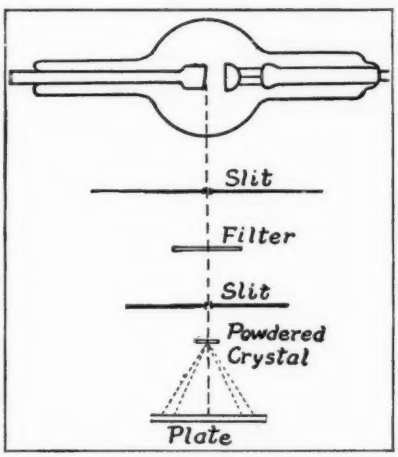
This must be so, because each wave of the sound is reflected from the barn, and as many waves return as strike, so the frequency or pitch of the echoed wave is the same as that of the original wave. Similarly an X-ray echo should be thrown back by the electrons in the scattering material, and should have the same pitch or frequency as the incident rays. Thus the wave theory does not account for the lowered pitch which the scattered X rays are found to have.



"PERHAPS THE BEST PICTURE"

Figure 15: Sheets of photons may make up electromagnetic waves. The wave is represented above; the sheets of photons corresponding to it are below

The corpuscular idea revived by Einstein suggests, however, a simple explanation of this effect. On this view, we may suppose that each X-ray photon is deflected by a single electron, just as, for example, a golf ball might bounce from a football.



HULL'S APPARATUS

Figure 16: Used for performing X-ray diffraction experiments with crystals. Thomson uses an analogous apparatus

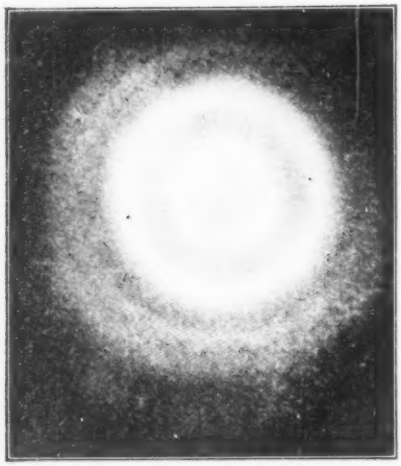
The football will recoil from the golf ball, and part of the energy is spent in setting the football in motion. Thus the golf ball bounces off having less energy than when it struck. In the same way, the electron from which the X-ray photon bounces will recoil, taking part of the photon's energy, and the deflected photon will have less energy than before it struck the electron. The reduction in energy of the X-ray photon corresponds on Einstein's view to a decrease in frequency of the scattered X rays, just as the experiments show. In fact, the theory is so definite that it is possible to calculate just how great a change in pitch should occur, and the calculation is found to correspond accurately with the experiments.

Within a few months after this new theory of the scattering of X rays had been proposed, Dr. C. T. R. Wilson was able to photograph the trails left when electrons in air recoiled from X rays which they scattered. In Figure 13 there are two high-speed beta particle trails at top and bottom. These are photo-electrons. Between them are shorter trails left by electrons recoiling from X rays which they have scattered. Notice how those which are knocked straight ahead go farther than those which received a glancing blow. Thus we have observed not only the loss in energy of the deflected golf balls, but also the footballs, or electrons, from which they have bounced.

Finally it was found possible to follow not only the electron which recoiled from the impact of the X ray, but also the path of the deflected X-ray particle as it bounced from the electron. Through the air in a cloud expansion chamber (Figure 2, February issue) was passed a beam of X rays so faint that we would find only one or two electrons recoiling from the scattered X rays, as in Figure 14.

NOW if the recoiling electron moves downward, the X-ray particle must have glanced upward, just as when the golf ball bounces to one side the football recoils to the other. If, however, the scattered X ray goes as a wave, spreading in all directions, there is no more reason to expect it to affect a second electron on one side that on the other. The photographs show that the second electron struck by the scattered X ray is on the side corresponding to A of Figure 14, opposite to the direction of recoil of the first electron. An X ray is thus scattered in a definite direction, as it should be if it is a particle.

But if X rays consist of particles, so also must light and heat rays, for they are all the same kind of thing. For centuries it has been thought that the corpuscular and wave conceptions of the nature of light are contradictory; but when we are confronted with apparently convincing evidence that light consists of particles, the two conceptions must in some way be reconcilable. The theoretical physicists are hard at work on a reconciliation of the two theories. One suggestion is



DIFFRACTION OF ELECTRONS

Figure 18: Diffraction pattern obtained by passing a pencil of electrons through powdered crystals of gold. See Figure 17

that the energy of radiation is carried by the particles and that the waves serve merely to guide the particles. According to the second view, the particles of radiation exist in any true sense only when the radiation is acting on atoms or electrons, and that between such events the radiation moves as waves. These ideas, however, are difficult to state in any satisfactory form.

Perhaps the best picture that one can give of the relation between waves and particles is the analogy of sheets of rain which one sometimes sees in a thunderstorm. We may liken the waves to the sheets of rain that one sees sweeping down the street or across the fields. The radiation particles or photons would correspond to the rain drops of which the sheet is composed. Such an idea is pictured in the diagram, Figure 15.

THIS conception is probably fairly accurate when we are thinking of radio rays. For in the case of radio rays, even a feeble signal, such as one broadcast from Los Angeles and heard in New York, would have waves consisting of thousands of photons per cubic inch. But in the case of X rays, a single photon carries enough energy to detect—and one particle is difficult to arrange in sheets.

The fact remains that the evidence before us seems to demand that light and other forms of radiations consist both of waves and of particles.

If then, light, which has long been known as waves is now found to consist of particles, may it not be that such things as atoms and electrons which have long been known as particles may have the characteristics of waves? Thus reasoned the French physicist de Broglie. He went so far as to calculate what the wavelength of an electron should be when moving at a certain speed. The calculation indicated that the wavelength of an electron moving at moderate speed is about the same as the wavelength of an X ray.

Now it is not many years since the wave characteristics of X rays were demonstrated by finding that they may be diffracted by crystals. De Broglie's suggestion was accordingly tested during the last year by two Americans, Davisson and Germer, by diffracting an electron stream from a crystal in the same way. They found in these experiments the same kind of interference effects that Laue and the Braggs had observed with X rays.

About a year ago I had the pleasure of calling on Sir J. J. Thomson, who did so much to establish the corpuscular nature of the electron. His son, G. P. Thomson, was home on a visit, and was telling his enthusiastic father and myself of his new experiments on the diffraction of electrons. This experiment was the analogue of Hull's powder method of diffracting X rays by crystals.

HULL'S apparatus may be illustrated by Figure 16. A beam of rays passes through a pair of slits and traverses a mass of powdered crystals which throw a diffraction pattern on the photographic plate. Using a beam of X rays of a definite wavelength traversing a mass of aluminum crystals, Hull obtained the photograph shown in Figure 17.

In Thomson's experiment, the X-ray tube was replaced by the cathode of a vacuum discharge tube. The electrons in the cathode ray stream were shot through a thin sheet of gold leaf (which replaces the powdered crystals in the X-ray experiment) and then fell on the photographic plate. Figure 18 shows the result. By the close similarity between Figures 17 and 18, Professor G. P. Thomson was able to convince his father, as well as the rest of us, that we now have precisely the same kind of evidence for believing in the wave characteristics of electrons that we have for believing in the wave characteristics of X rays.

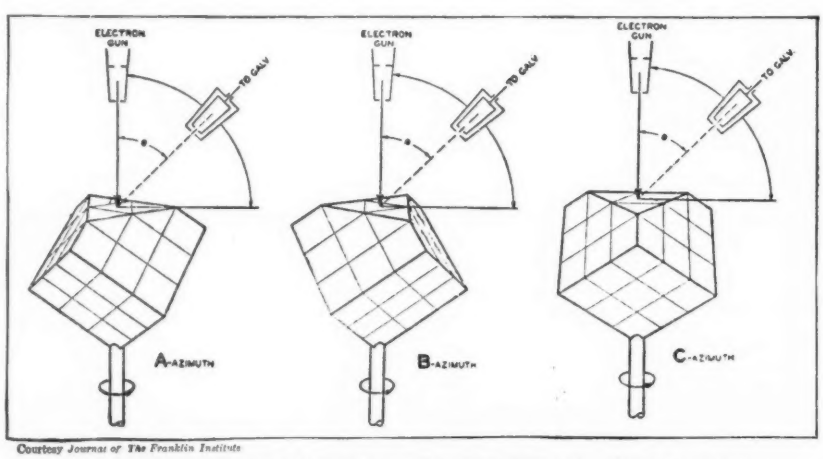
Our paradox of waves and particles is thus not confined to the nature of light, but applies to electrons as well. Atoms and molecules are now also being treated as complex bundles of waves. Light which we have long thought of as waves has the properties of particles; and electrons which Figures 7 and 8 show so clearly as particles have the properties of waves. There seems to be a dualistic aspect to these fundamental entities. The distinction between the conceptions of waves and particles may not be as sharp as we have thought.

HOW then does the matter stand? The tangible objects with which we are familiar we find constituted of molecules. These, in turn, are composed of atoms and these of positively charged and massive protons and the negatively charged and mobile electrons. The light which makes plants grow and which gives us warmth has the double characteristics of waves and particles, and is found to consist ultimately of photons.

Having carried the analysis of the universe as far as we are able, there thus remain the proton, the electron, and the photon—these three. And, one is tempted to add, the greatest of these is the photon, for it is the life of the atom.

We sometimes think of standardization as being the distinctive keynote of modern industry. But even a Ford car has hundreds of parts that differ from each other. What, then, shall we say of the Workman who by using only three different parts, protons, electrons, and photons, has made a universe with its infinite variety of beauty and life?

THE END



Courtesy Journal of The Franklin Institute

APPARATUS FOR INVESTIGATING ELECTRON DIFFRACTION

Electrons from a tungsten filament are accelerated by an electron gun; they strike a crystal of nickel and are received by an adjustable collector. The three positions permit measuring intensity of scattering of electrons not only at various angles but three azimuths, derived from the molecular structure of the crystal. An experiment performed by Davisson and Germer

OUR POINT OF VIEW

Aviation Strides Ahead

A QUARTER of a century ago—in 1903, to be exact—the Wright brothers, Wilbur and Orville, made the first successful flight in an airplane at Kitty Hawk, North Carolina. At the dedication of Wright Field, Dayton, Ohio, several months ago, Orville Wright watched many airplanes roar by in a terrific race. A direct question, put by someone nearby, seemed to carry his thoughts back to the days of the early experiments of his brother and himself, and he is said to have sighed and answered slowly: "No, neither of us thought it would ever come to this."

In its 25 years, aviation has made undreamed-of strides despite the fact that the first five of those years were required to convince the world that man *could* fly. After little more than another five years, a war showed the great military value of airplanes and, because of the extensive use of them under trying circumstances, gave a hint of their potentialities during peace time. Following that conflict, the field of their usefulness was greatly expanded: mail and passenger air lines were started; oceans were crossed; the arctic was explored and the North Pole reached by hardy aviators; and just the other day, five army men stayed aloft in a three-motored airplane for over 150 hours.

"Stride" would seem an inept term to use in connection with machines that fly, were it not that aviation is now in the big business class. An indication of what may be expected in the future is seen in the announcement recently of an air transport and manufacturing merger which has a capitalization of 150,000,000 dollars! Those who have kept abreast of the developments in this great industry can well understand, therefore, why we have devoted this issue largely to aviation.

Identify Your Town

POSTMASTER-GENERAL NEW has endorsed, and the Departments of War, the Navy, and of Commerce are co-operating in, the campaign for the identification of towns and cities by roof markings, recently begun in an intensive way by The Daniel Guggenheim Fund for the Promotion of Aeronautics. The Fund's first step in this movement was to enlist the aid of postmasters in towns of from 1000 to 50,000 population. This group of public servants provides a nucleus for the project but these men, in a great many cases, can do scarcely more than initiate the movement in a small way in their towns. The active work of more influential men and of organizations is necessary.

The job, for any given community, is not a big one—insofar as the actual work and expense are concerned; but, judging from the general apathy with which previous agitation for such identification markings has been received, it is Brobdingnagian. Smug little towns and lethargic big ones, all fail, apparently, to realize that aviation is well established, that it is now part and parcel of the nation's business and is rapidly becoming more so every day. Apparently, also, they neglect to take cognizance of the fact that the air mail is a strong link in the chain of progress yet must be strengthened further, if not for the sake of the important mail carried, then for the sake of the pilot whose life may be forfeit because he cannot get his bearings. The speed of the air mail helps make possible greater prosperity because it expedites the transactions of business and industry.

A few gallons of paint, a convenient roof top or two, of appreciable size, and the services of a painter for two or three days: that is all that is necessary to identify a town properly. And yet very few towns so far have shown that they are not of the smug or lethargic type, although some industries, notably oil corporations, have marked their roofs. What is hard to understand is that practically every sizeable city in the country has not already identified itself in this manner. It should be a matter of civic pride.

President Hoover

AN event, unique in the annals of the United States, takes place on the fourth of March: the first engineer to hold the office of chief executive of the nation will be inaugurated. Other presidents have had some engineering experience, but none has had such complete, world-wide, and successful engineering experience as Herbert Hoover.

Prophecy is cheap; it is easily dispensed, gladly accepted by those who *want* to believe it, and flatly contradicted by those who don't. Predictions of what will transpire during Mr. Hoover's administration, or even conjectures, are practically valueless and will be omitted here. Mr. Hoover takes the office with such a well-rounded knowledge of human, national, and international affairs, however, that it is believed that the United States will assume a higher place as a world power under his leadership.

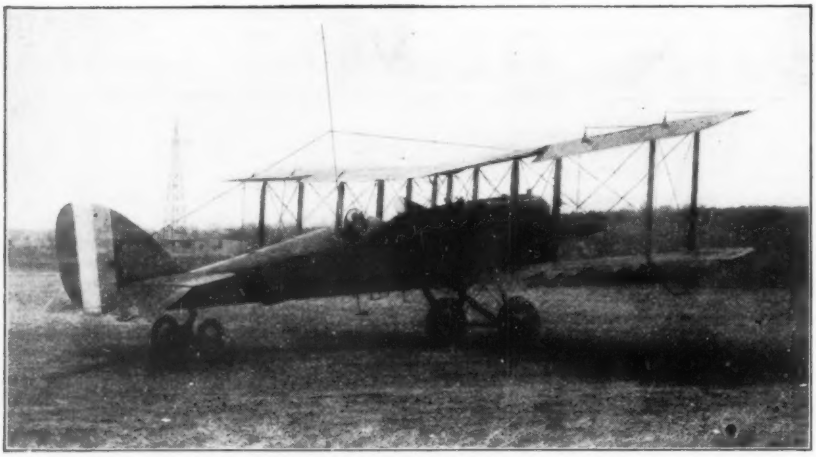
Recently, an asteroid, or miniature planet, discovered by Professor Johann Palisan of Austria, was named "Hooveria" by a unanimous vote of the senate of Vienna University, in honor of the man who fed starving, war-worn Europeans during the World War. The fact that our new president commands such respect and admiration abroad leads us to hope that our international relations will be greatly improved during his administration. What with misunderstandings concerning questions of policy, armaments, war debts, et cetera, they are, indeed, sadly in need of improvement.

Bringing the Ultra Violet Indoors

NEXT month we expect to publish the interesting answers to our questionnaire on special window glass for transmitting the ultra-violet rays of the sun for health purposes. We have sent this questionnaire to a limited, selected list of specially qualified authorities—chiefly, noted physicists and physicians who specialize in ultra-violet radiation. The replies already received are gratifying. They show that these foremost authorities have put serious thought upon the question. Many have expanded their answers to considerable length elucidating their opinions and we dare anticipate that the ultra-violet transmitting glass questionnaire, when published, will attract widespread and long-continued attention.

The most interesting replies were provoked by the simple inquiry whether the public is justified in purchasing this special glass for homes, nurseries, schoolhouses, workshops, and offices, particularly in those cases where the ones who expect benefit cannot sit in the direct, transmitted sunbeams.

While mentioning ultra-violet transmitting glass we wish to make as clear as we possibly can one point which has apparently been widely misunderstood. In 1928 it was discovered that even the best of the glass loses some of its transmitting powers after a few weeks of exposure to the sun. After hearing of this unexpected phenomenon many appear to have concluded that this depreciation continues indefinitely, and that the glass finally loses all of its special advantage. This, however, is far from the case. There is unanimous opinion among physicists who have conducted tests that this depreciation comes to a virtually permanent stop after passing a certain part-way point.



A BEACON-EQUIPPED PLANE

The ten-foot vertical rod is the antenna which serves to pick np the radio waves emanating from the radio-beacon transmitter. It replaces the old cumbersome, dangerous trailing wire

Radio Guides the Airway Traveler

Radio Beacons Provide Increased Safety In Fog and Storm

By ARMSTRONG PERRY

ON stepping into the pilot's seat of an up-to-date airplane, the pilot or student aviator faces an instrument board containing, among other instruments, a radio-beacon indicator. This device enables him to keep his ship on a course that is marked by aircraft radio beacons.

IN THE COCKPIT

Directly below the rim of the cowling is seen the reversible radio-beacon indicator

The airplane is equipped with a vertical rod antenna ten feet high. The trailing wire antenna, which more than any other has been used on airplanes in the past, is dangerous and is not suitable for use with radio-beacon receivers. Therefore, the pilot no longer has to remember to unreel a long wire and reel it in again before landing, and he does not have to worry for fear that the "lead fish," used to hold the trailing wire steady in the air, will fall off and harm someone on the ground.

THE United States Government has lighted 11,000 miles of airways for night flying and is providing powerful searchlight beacons for other routes as fast as possible, but clouds, fog, and storms often prevent air pilots from seeing these lights.

Radio beacons are necessary in order that airplanes may depart and arrive on time and maintain dependable service. They have been developed by the United States Bureau of Standards and are being installed on the principal airways by the Department of Commerce. The radio-beacon indicator on the instrument board enables the pilot to keep on the course marked by one of these beacons, whether or not he can see beyond the nose of his plane.

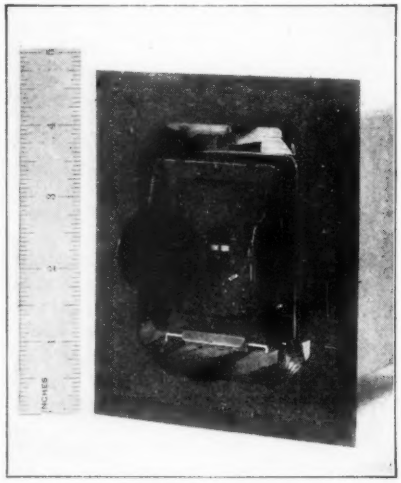
The indicator is connected with a small radio receiver which is installed in the tail of the airplane or in some other place where it is out of the way. This receiver is tuned to the wavelength of the radio-beacon transmitter before the airplane leaves the ground. The transmitter is located just outside the landing field.

As soon as the airplane is in the air and headed in the general direction that it is supposed to take, the pilot starts the radio-beacon indicator by pressing a button or throwing a switch. Two slender metal reeds with white tips, that have been motionless on the face of the indicator, begin to vibrate.

THE white tips move so rapidly that the eye scarcely can see their motion, and they form white lines that are easily seen against their black background. There is enough black space between the two lines so that each can be seen separately and distinctly.

So long as the two white lines are of equal length, the airship is on her course. If the line at the right grows longer, that shows that the ship is getting off her course and is to the right of it. If the line at the left grows longer than the one at the right, that shows that the ship is to the left of her course.

This radio-beacon indicator will guide the pilot unerringly along his



THE INDICATOR

Here the instrument is removed from its case. The reeds show plainly. Note size

route so long as he stays on the course and keeps the two white lines of equal length. The course marked by the radio beacon transmitter is only from 3½ to 5 degrees wide. If the pilot flies out of this area, as he may do in order to avoid a storm, he will, of course, know whether he flies to the left or to the right of it and will watch his compass and know the general direction of flight. When he wishes to return to the course, he steers in the general direction of it and keeps on until the white lines on the indicator

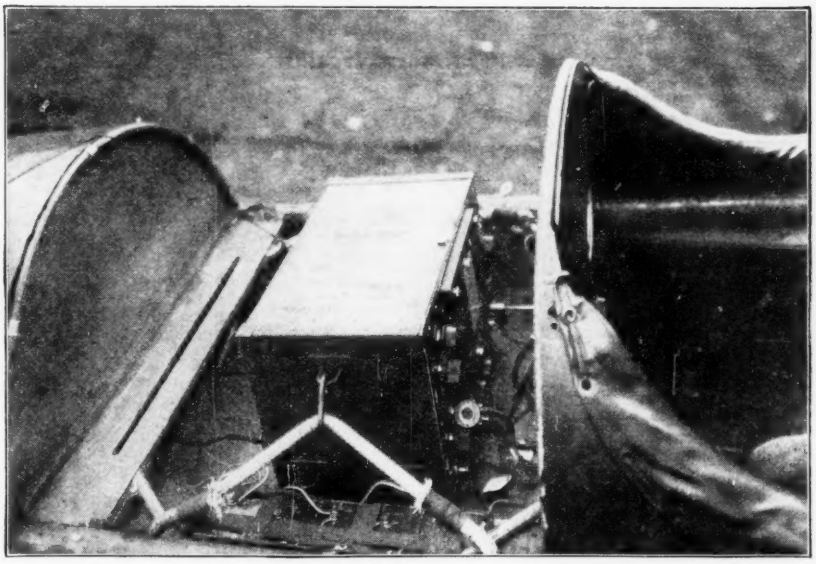
show that he is back again between the edges of the beam from the radio-beacon transmitter.

Where the course between two airports two hundred miles or more apart is a straight line, radio marker beacons may be found about 25 miles apart. An airplane that flies regularly on such courses will have a radio-beacon indicator that shows an additional white line. This line may not remain steady like the two others, but may appear and disappear like the flashing light of a lighthouse. Its signals correspond with those of the beacon light in the same locality. The pilot, seeing the signal again and again on the indicator, can tell by a glance at his map exactly where he is. By noting his time of arrival at one marker beacon after another, he can tell what speed he is making and how much the wind is helping or hindering.

WHEN the airplane reaches its destination and turns back toward the radio beacon that has guided it, the radio-beacon indicator on the instrument board is turned end for end. One end is marked "From Beacon" and the other end "To Beacon," so that no mistakes will be made.

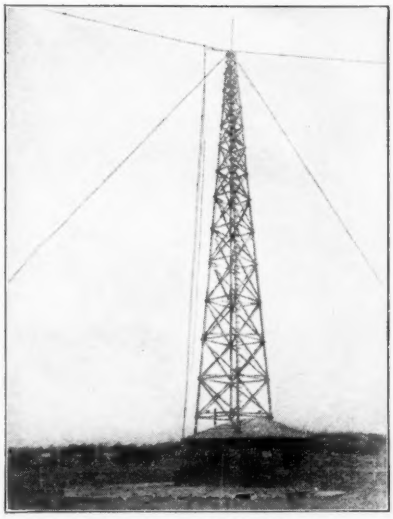
Besides keeping the plane on its course, and helping the pilot to find the course if he is not on it, the radio-beacon receiver also brings to the pilot information concerning the weather ahead. He may, if he chooses or if he is ordered to do so, wear a helmet in which ear phones are installed. He carries a schedule showing the times at which weather reports and storm warnings are to be sent by radio telephone from the radio-beacon stations or from other stations.

At the appointed time, he turns a knob on the instrument board or, if the radio receiver is within easy reach, he turns a knob on it. In either case the knob is stopped at the proper place for bringing in the weather report.



THE RECEIVER

This part of the equipment, permanently tuned, is located wherever convenient



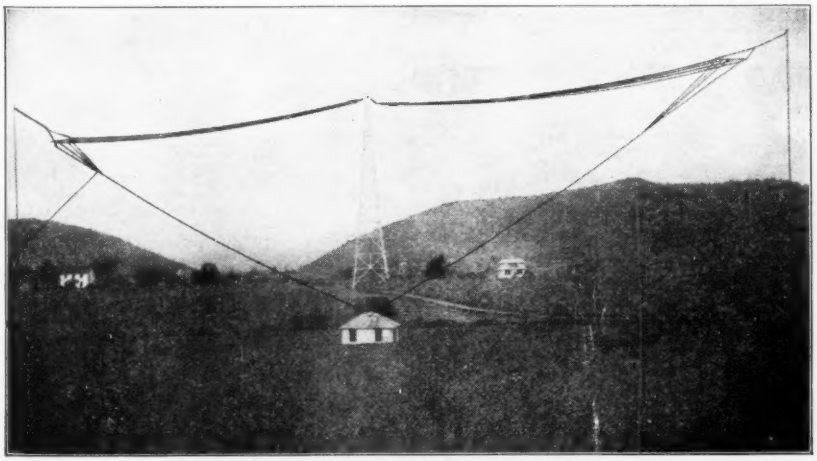
TELEPHONE TRANSMITTER

From this remote controlled station at Bellefonte, Pennsylvania, are sent weather reports and the like, for warning pilots

There is no fishing for stations. When he has heard the weather report, and any other information that is being transmitted for the use of pilots in the air, he turns the knob back to its original position.

In early experiments with aircraft radio beacons, signals from the beacons were received through ear phones instead of with the visual indicators now in use, but this method was discarded. Continual listening was too hard on the pilot.

The reason for the action of the white lines on the face of the radio beacon indicator is easy to understand. The beacon transmitter sends out two radio beams like invisible fences on either side of an invisible road, in the air. When the ship steers too close to the fence at the right, the vibrating reed on that side becomes excited, vibrates more strongly, and makes its white line longer.



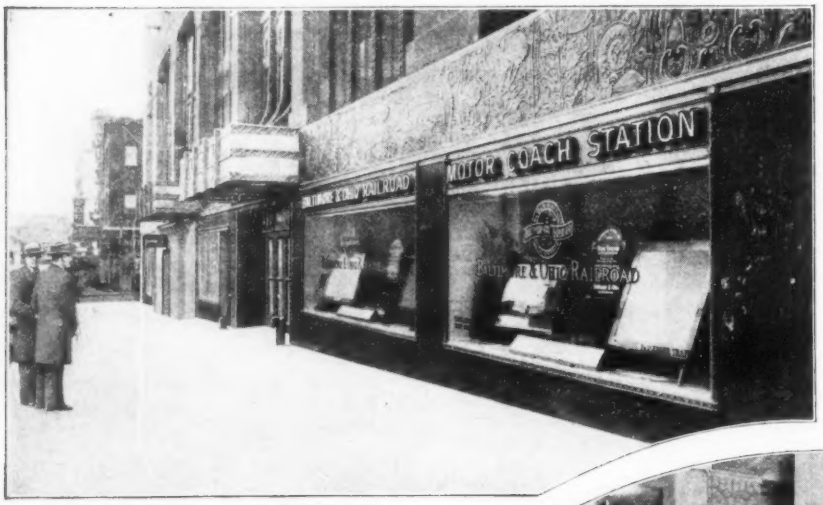
RADIO-BEACON SIGNAL STATION

These towers and aerials are located just outside the landing field at College Park, Maryland. From here the narrow radio beam goes forth to guide aviators unerringly safe to port

THE radio beacon indicator is one of the final instruments needed on the instrument board to make flying safe and to make the airplane a dependable means of transportation. Pilots often are obliged to depend on "instrument flying" when they cannot see the ground. The altimeter shows a pilot his altitude. The tachometer shows him the speed of his engine. The air-speed indicator shows him his speed in the air but he can only guess at his speed over the ground unless he knows exactly where he is from time to time. The bank and turn indicators show when the airship is banking and turning. The compass shows the general direction. But none of these, nor all of them together, show whether the ship is on or off its course, which is what the radio beacon does.

New York's New Railroad Bus Station

Motor Coach Service, a Permanent Link in a Great Railroad System, Has a Fine New Terminal In Manhattan



STATION FRONT AND ENTRANCE
The attractive entrance of the new motor coach terminal on 42nd Street, New York City

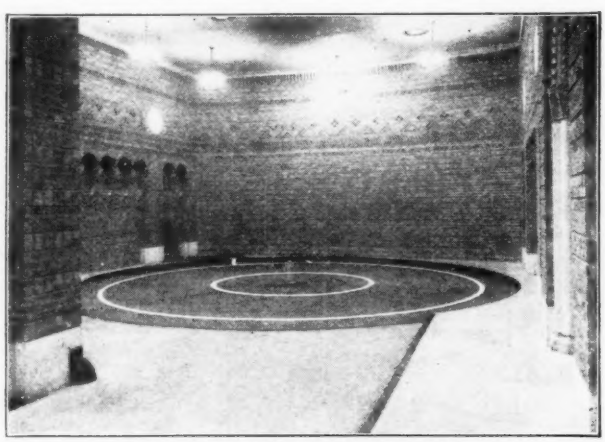
ON December 17, 1928, the Baltimore and Ohio Railroad opened opposite Grand Central Terminal and the Hotel Commodore, New York, a modern station to care for its ever-increasing motor coach traffic from its rail terminal in Jersey City to Manhattan. The new station is but a few doors away from the smaller Train Connection Motor Coach Service terminal the railroad had used since August, 1926. This service is an integral part of the railroad's service, only passengers to and from New York being carried in its buses; holders of regular tickets ride these buses without extra charge.

The main lobby of this station is impressively attractive and reminds one of a luxurious hotel lobby. While the decorations are, mainly, modernistic, large leather-upholstered chairs and settees give an air of spacious comfort. The lighting is indirect from modernistic chandeliers and column units.

The passenger buys his ticket in the main lobby, checks his luggage directly to his Pullman seat in the train, goes to the waiting room in the rear, and awaits his bus. The buses enter the building from 41st Street, discharge passengers, are turned around upon a turntable, are loaded, and driven out a door beside that through which they enter. Busses stop at another station and at hotels enroute.

MAIN LOBBY AND TICKET COUNTER
Doors in the rear lead to waiting room, loading and unloading platforms, and retiring rooms. A stairway leads to tunnels connecting with subway system

BUS ENTRANCE AND EXIT
Motor coaches enter at the left, discharge passengers, turn on the turntable, and receive outgoing passengers on the right platform



ELECTRICALLY-OPERATED TURNTABLE
When a motor coach is driven upon this 30-foot circular table, the throwing of a control lever turns the table in less than a minute

Super-High-Speed Alloy

New Tool Metal, Next to the Diamond In Hardness, Solves Many Machining Problems

CUTTING a screw thread in a glass rod, boring a smooth hole in a block of concrete, handling porcelain in a lathe, and cutting the hardest of steels—operations that are difficult or even impossible with present-day machine tools—are among the things that can be done easily with a new kind of machine tool material recently announced by Dr. Samuel L. Hoyt of the General Electric Company. The new material, called Carboloy, is composed of tungsten carbide and cobalt, the carbide being extremely hard and the cobalt giving it the necessary strength for cutting tools. Carboloy now sells for around 500 dollars a pound and it is, therefore, used only in tipping machine tools.

Dr. Hoyt said, "The peculiar virtues of tungsten carbide promise to make it the dominant tool material in the field of weak, or 'low tensile,' materials which are also uncommonly abrasive to present tools. The new material can machine harder and denser grades of steel than can be handled economically by high-speed steel; and steels not now commercially machinable will be brought into the machineable class."

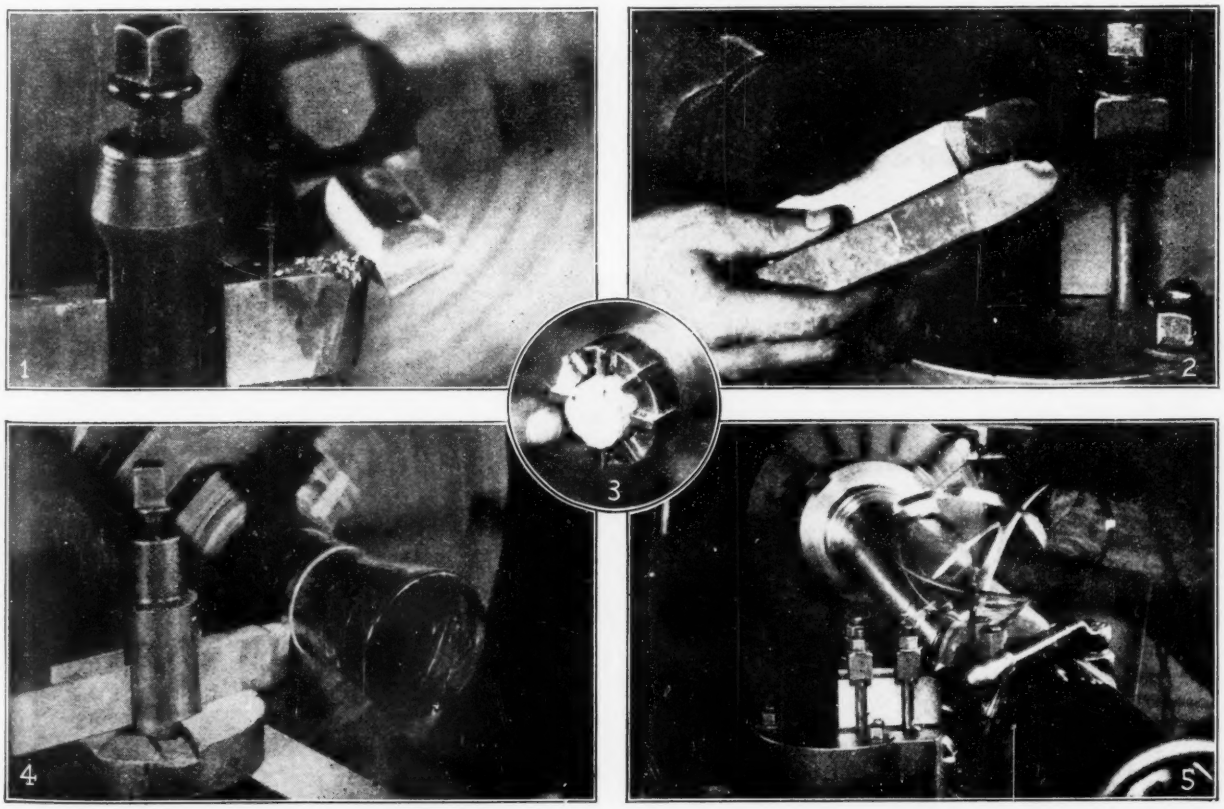
Usual cutting tools will not affect a glass rod; instead, a rod of glass in a lathe will wear off the edge of a cutting tool pressed against it. The Carboloy tool quickly cuts into the glass, and can be used for cutting a screw thread in the rod. Likewise, porcelain can be machined on a shaper with it. A Carboloy drill for drilling holes in concrete or rock is less expensive than a diamond drill and cuts a smoother hole than a star hammer drill.

ONE important use for the new alloy is in the cutting of molded materials, such as hard rubber, fiber, et cetera, containing metal inserts. Striking the inserts at high speed, ordinary tool metal is rapidly dulled, and even the best previously used for this work require sharpening after machining 150 parts, whereas Carboloy tools have cut 11,000 parts before they required dressing. Other materials so soft that they can be whittled with a knife but also so abrasive that they quickly destroy the cutting edge of ordinary tool steel, are easily machined with Carboloy tools.

The photographs below show: (1) Cutting a high-speed steel cutter in a lathe with Carboloy; (2) Comparison of high-speed steel and Carboloy after use on nickel-steel test log—the steel cutter (lower) is burned while the Carboloy cutter has not been affected; (3) Carboloy drill with core of concrete; (4) Cutting glass on a lathe with Carboloy; (5) Testing Carboloy cutter on a nickel-steel test log. This last test is a very severe one and would quickly destroy the edge on high-speed tool steel. Note the thick ribbons of metal being cut with Carboloy.

DR. SAMUEL L. HOYT

Dr. Hoyt holding glazed porcelain and Bakelite cut with Carboloy; cutters, made of the new tool metal, are in his right hand



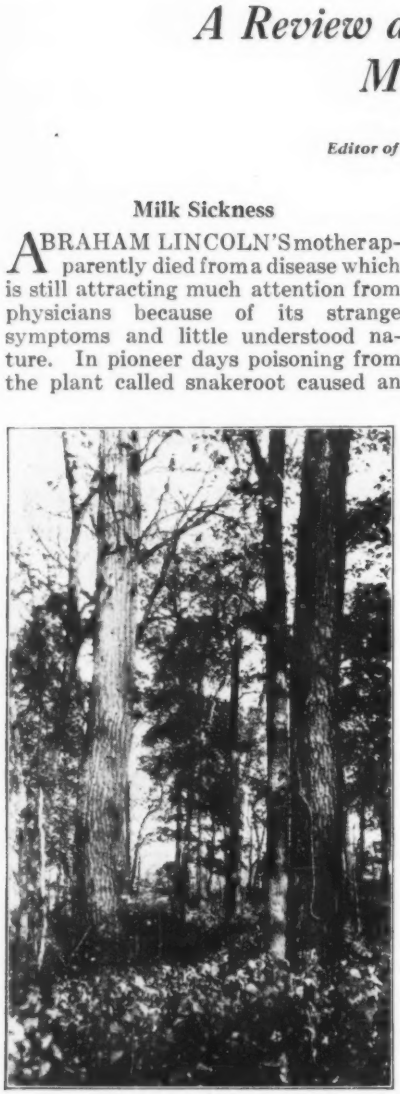
The Month In Medical Science

A Review and Commentary on Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

Milk Sickness

ABRAHAM LINCOLN'S mother apparently died from a disease which is still attracting much attention from physicians because of its strange symptoms and little understood nature. In pioneer days poisoning from the plant called snakeroot caused an



MILK SICKNESS LOCALE

A typical habitat of *Eupatorium urticaefolium*, the plant which causes milk sickness, apparently through the milk of cows which eat it when they are foraging

appalling loss of human life. The earlier settlers were not quite certain just what brought about the condition. Apparently it was traced to milk coming from cattle which had eaten a plant known as the white snakeroot or *Eupatorium urticaefolium*. When the cattle ate the plant they were afflicted with the condition called "trembles." In the southwestern portions of the United States, a similar condition results from rayless goldenrod called *Aplopappus heterophyllus*.

In a recent investigation of the condition, made by Drs. Bulger, Smith, and Steinmeyer of St. Louis, it was revealed that the usual course of the disease is onset with restlessness, weakness and exhaustion, dizziness and vomiting. Soon intense thirst prevails, the weakness increases, the liver enlarges, the tongue becomes swollen, convulsions follow and finally, death after unconsciousness for two or three days, or even one or two weeks. The acute attack is so severe that even those who recover sometimes remain weak for years.

Modern scientific medicine studies such conditions by thoroughly investigating the changes that take place in the blood and in the excretions of the body. These studies now reveal that there is a very much lessened amount of sugar in the blood during the acute stage of this disease, and that the conditions which develop are quite similar to those that follow an overdose of insulin, which also lessens greatly the amount of sugar in the blood.

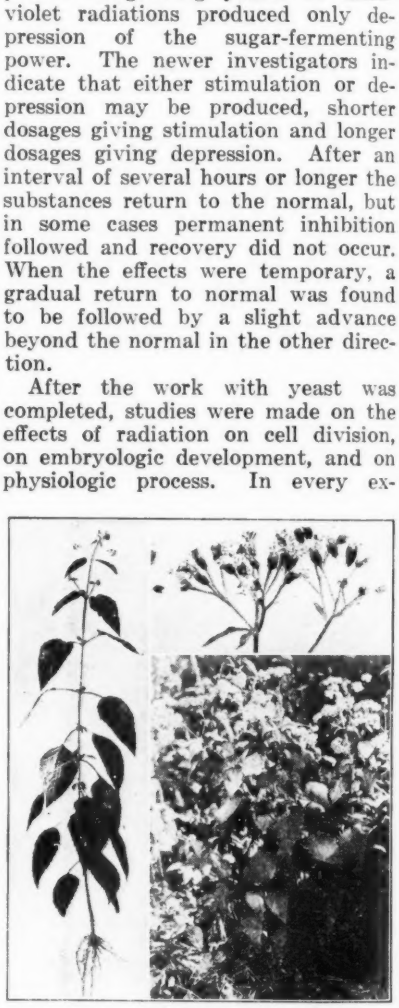
The plants, as seen in one of the illustrations, grow in woodlands and deep valleys and thrive especially where shade is abundant. Two years ago, out of a family of six using milk from cows pastured in the woods shown in the illustration, five died of the disease. As is well known, severe exercise makes a great demand on the sugar metabolism of the body. Hence a person recovering from this disease is warned against taking up work too soon. The father in the family of six, who was the least ill and had improved somewhat, felt that his farm work should be resumed. He got up and ploughed. That night he became much worse and died on the following day.

Effects of Rays on Tissues

THE investigators of the use of ultraviolet rays have been attempting to determine whether the effectiveness is dependent on the length of the wave used or on the dosage of rays given. The factor which decides whether the effect of the ray is to be stimulative or inhibitive seems to depend on the quality rather than on the quantity. A number of investigators, including some of the leading men in the field, have found that it is possible to produce both types of effect with the same region of the spectrum and they argue that the matter of dosage is of the greatest importance in determining whether the effects shall be stimulation or depression.

In order to study the matter more closely, Dr. Marie A. Hinrichs of the University of Chicago tested the effects of radiation on growing yeasts. Earlier studies reported that the exposure of growing yeasts to ultraviolet radiations produced only depression of the sugar-fermenting power. The newer investigators indicate that either stimulation or depression may be produced, shorter dosages giving stimulation and longer dosages giving depression. After an interval of several hours or longer the substances return to the normal, but in some cases permanent inhibition followed and recovery did not occur. When the effects were temporary, a gradual return to normal was found to be followed by a slight advance beyond the normal in the other direction.

After the work with yeast was completed, studies were made on the effects of radiation on cell division, on embryologic development, and on physiologic process. In every experiment it was found that short exposures to radiation stimulate and longer exposures depress the activity.



REPRESENTATIVE SPECIMENS

White snakeroot, *Eupatorium urticaefolium*, usually more branched than shown here. See also photograph at left

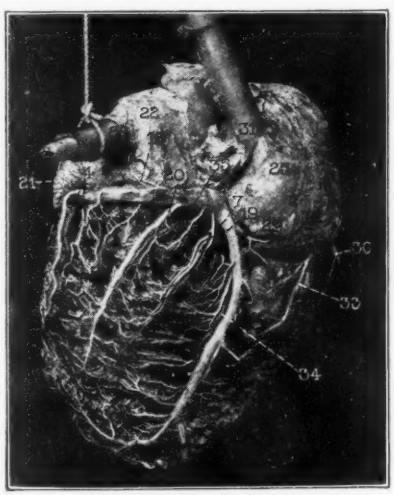
An Unusual Drug

DURING the past year medical periodicals have contained numerous references to the extraordinary action of a drug known as thallium acetate. The chief use of the remedy

seems to be in afflictions affecting the scalp, in which it is necessary to remove the hair. This applies particularly to the disease known as ringworm of the scalp which affects children, passing from one to another in schools. When the drug is given in proper dosage to the child, the hair will start to fall off in from nine to fourteen days and in about three weeks all of the hair will have disappeared from the head. After about four weeks, the hair starts to grow again and returns in as good condition as it was previously. During the period when the hair is absent, it is possible to apply the proper antiseptic drugs to kill the organisms responsible for the condition of the scalp, and thus to bring about a cure of the disease.

The Circulation of the Heart

FROM the beginning of man's earliest knowledge of the human body, the heart has attracted a major portion of attention. The ancients conceived it to be the seat of the soul. Everyone knew that if it stopped beating, the human being would die. Just as soon as it become possible to dissect the human body, the heart was studied by that method. When animals were employed for experimentation the chests were laid open and hearts observed actually at work. In modern times other methods are involved, including the injection of



CELLULOID HEART CAST

The ramifications of the heart of a ten year old girl are indicated by this intricate cast made by the process described herewith

dye substances into the blood vessels, the use of the X ray, of the microscope and of other technical apparatus.

A review of all of these methods has recently been made by Dr. M. B. Whitten of the Mayo Foundation who adds to previous methods a technique which he has developed for injecting the blood vessels of the heart with celluloid, dissolving away the tissue and leaving *en masse* a cast which reveals the manner in which the heart receives its blood supply. The importance of keeping the heart in good condition and with a full amount of blood will be realized from the extent of its circulation. The arteries are numerous and their ramifications profuse. The illustrations reveal the nature of this blood supply.

Do Eskimos Catch Cold?

DURING a trip up the west coast of Greenland, physicians from the Washington University Medical School in St. Louis noted that in certain settlements every native had a cold, whereas in others none of the Eskimos seemed to be afflicted. It was found that in the case of the villages in which all were afflicted, some one had come in from the outside world previous to the visit of the expedition. In the instances in which none of the natives were afflicted on the arrival of the expedition, in practically every case, within from 48 to 72 hours after arrival, all of the Eskimos had colds, with sneezing, coughing, and spitting.

Among these Eskimos colds are quite infrequent and diphtheria and scarlet fever occur rarely. Skin tests were made on the natives to discover whether or not they had resistance to scarlet fever and diphtheria, and it was found that in some instances the children had in their blood substances enabling them to resist these diseases, so that apparently some immunity is derived from the parents.

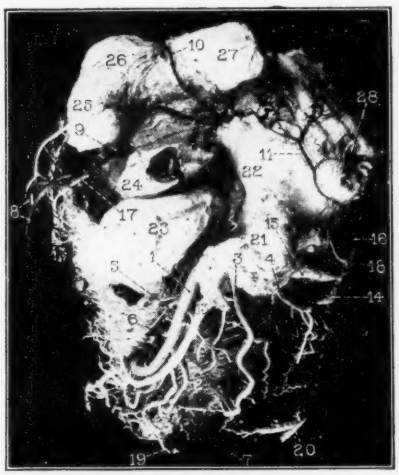
It has long been known that tribes of natives not previously in contact with the white man suffer severely with his diseases when they are introduced among them. Thus the Fiji Islands at one time were absolutely devastated by measles when the disease was brought in by outsiders. This condition, which, in the average white man, assumes a mild form, proved intensely fatal to a tribe which had not previously suffered from it.

When an epidemic of colds occurs in an Eskimo group, all who are without resistance get the colds. They recover and are not likely to have colds again unless a new strain of germs is brought in by other visitors.

Carrion's Disease

IN Peru, South America, there is a disease called oroya fever. In 1885 a medical student named Daniel A. Carrion attempted to establish the fact that this disease was similar to a condition called oroya fever and verruga, or "Peruvian warts." He inoculated himself in both arms with tissue juice taken from Peruvian warts, developed the fever and died, proving his point that the two diseases were the same. Since that time Barton, a Peruvian physician, discovered in the red-blood corpuscles of the patients with the disease certain rod shaped bodies which proved to be bacteria now called *Bartonella bacilliformis*.

Another American entomologist, Charles H. T. Townsend, showed that



ANOTHER CAST

This one was taken of the heart of a 44 year old woman. Compare with the ten year old girl's heart cast shown in the column at the extreme left of this page

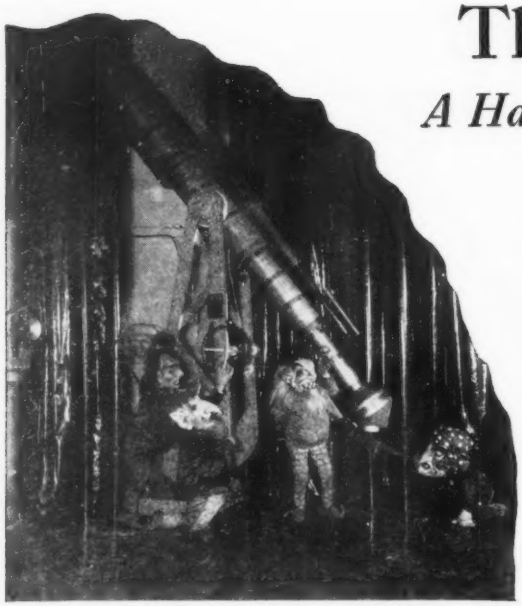
the disease was transmitted by a gnat which is now called *Phlebotomus verrucarum Townsend*. The history of this disease is a demonstration of the manner in which scientists in many places co-operate to establish definitely the nature of the diseases that afflict mankind from their causes to the methods of transmission, their symptoms, and finally their methods of control. In the development of our knowledge regarding Carrion's disease another investigator gave his life; others gave of their energy and toil with but little hope of material reward.

Home of Dr. Ephriam McDowell

IN Danville, Kentucky, in 1809, Dr. Ephraim McDowell, an American physician, did the first operation that was ever done on a woman for removal of the ovaries. The house in which this operation was done still stands in Danville. It is owned by a citizen of Danville and is occupied as a negro tenement. For many years attempts have been made to purchase this home in order that it might be established as a memorial to this pioneer surgical effort. The owner has unfortunately placed a prohibitive price on the property and apparently public sentiment has been insufficient to move him. The Danville Chamber of Commerce has attempted to acquire the building, which at the time the ovarian operation was first performed stood in the wilderness. In the history of American medicine this building is a monument indeed worthy of preservation.

The Devil Motorizes

A Hades of Iron and Steel, and Assorted Imps, Occupy the Stage

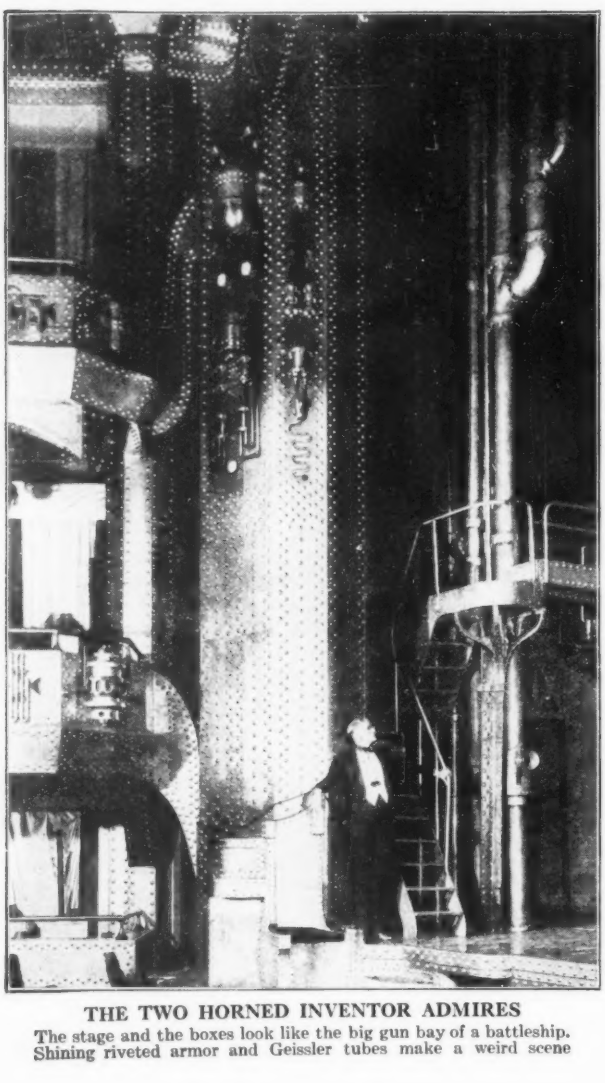


THE TELESCOPE LOOKS EARTHWARD

An apparently real and solidly constructed telescope is used in an attempt to locate a pure man on the earth

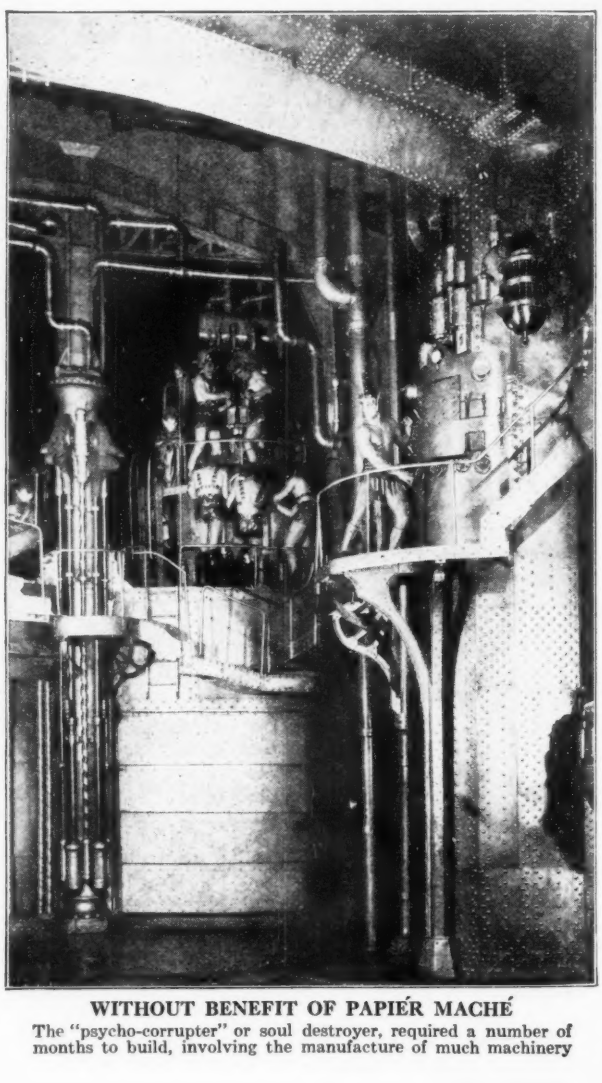
"MIMA" is a play in three parts and many scenes adapted by David Belasco from "The Red Mill" of Ferenc Molnar. It really is a miracle spectacle dealing with basic rather than merely surface emotions. To get away from the hackneyed eternal triangle, the tales of conjugal misfits, and the plotless drawing-room dramas was Mr. Belasco's problem. In "Mima" he does not stop with the stage, he comes right out into the audience and makes his proscenium arch the chord of a bridge. His boxes might be gun ports on a battleship and his stairs and runways suggest the engine room of a great transatlantic liner. The audiences are two in number, the paying guests—the audience—and the Devil and his court, for the scene is laid in Hades, Hell or whatever you want to call it. "Mima" is the superbly beautiful composite of the very dregs of sin. She is a manikin, the product of thousands of years of experiment by Magister, super-scientist of Hades.

But even Mima is but a part of Magister's scientific triumph. He has labored for 500,000 years to construct a huge apparatus, a complicated mill which he calls his "psycho-corrupter" and which he guarantees will transform the purest of souls into complete fiendishness in the space of one short hour. Rex Infernis and his



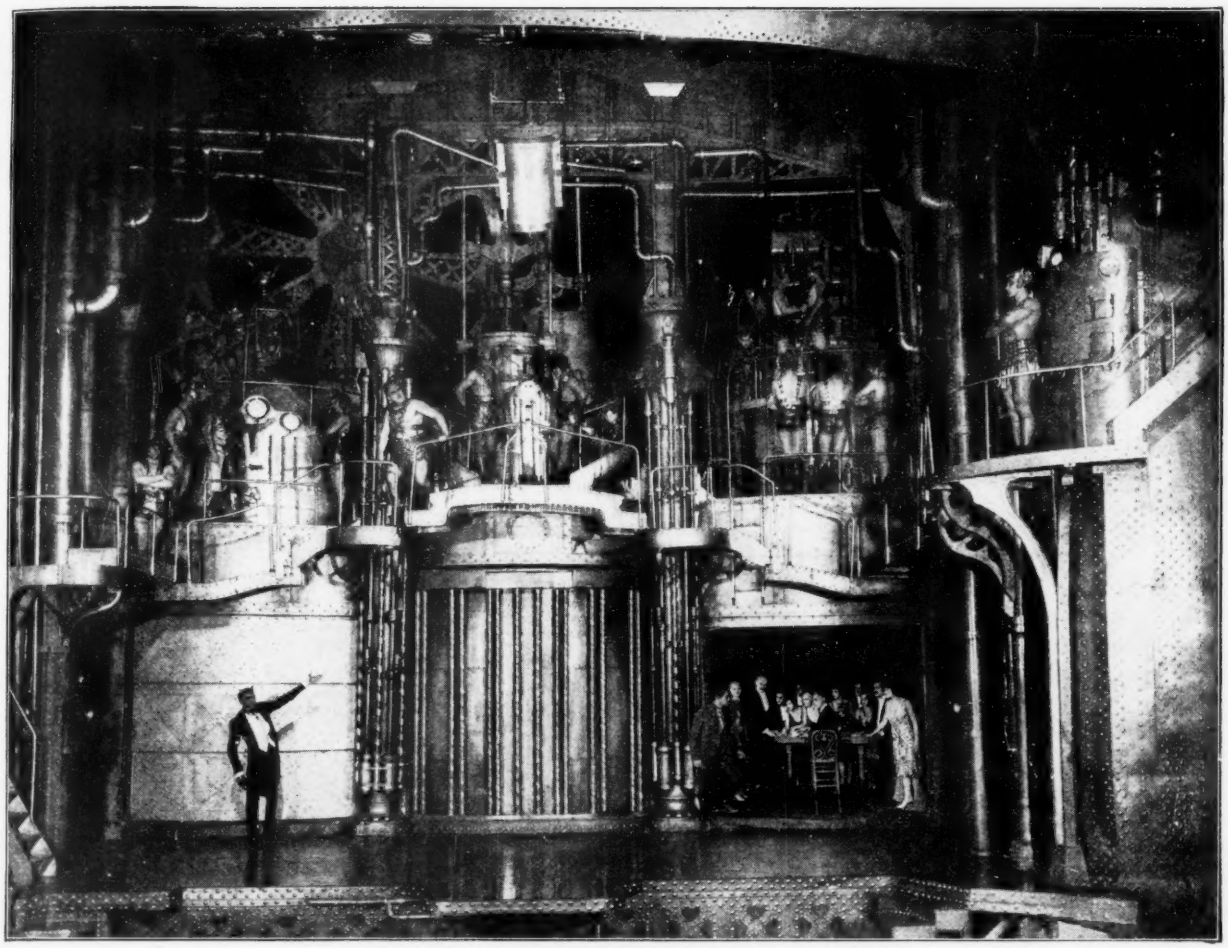
THE TWO HORNED INVENTOR ADMIRES

The stage and the boxes look like the big gun bay of a battleship. Shining riveted armor and Geissler tubes make a weird scene



WITHOUT BENEFIT OF PAPIÉR MACHÉ

The "psycho-corrupter" or soul destroyer, required a number of months to build, involving the manufacture of much machinery



THE GREAT MACHINE PROVIDES LITTLE STAGES

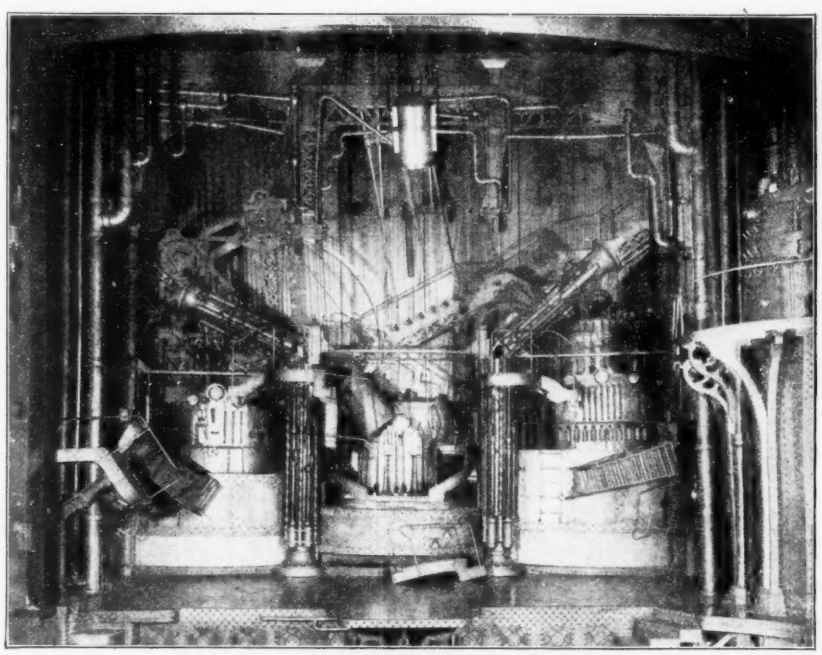
There are three cylinders which afford three bays for the setting of scenes. The doors rise and fall, or in the case of the center, rotate. All the various human emotions can thus be displayed to the devil and his entire court who occupy the "first row" in the orchestra

retinue of lesser devils come to witness a demonstration of the apparatus.

A soul is needed for the test, and Satan and his court inspect the world through a huge telescope to determine the identity of the victim. Finally Magister discovers his perfect man, Janos. Two of Hell's fiends are sent to bring this man before Satan and his court. Magister, now in the rôle of the proud scientist demonstrating his invention, plays his vari-colored lights on Mima who comes to life and instantly begins portraying all the rôles of womankind.

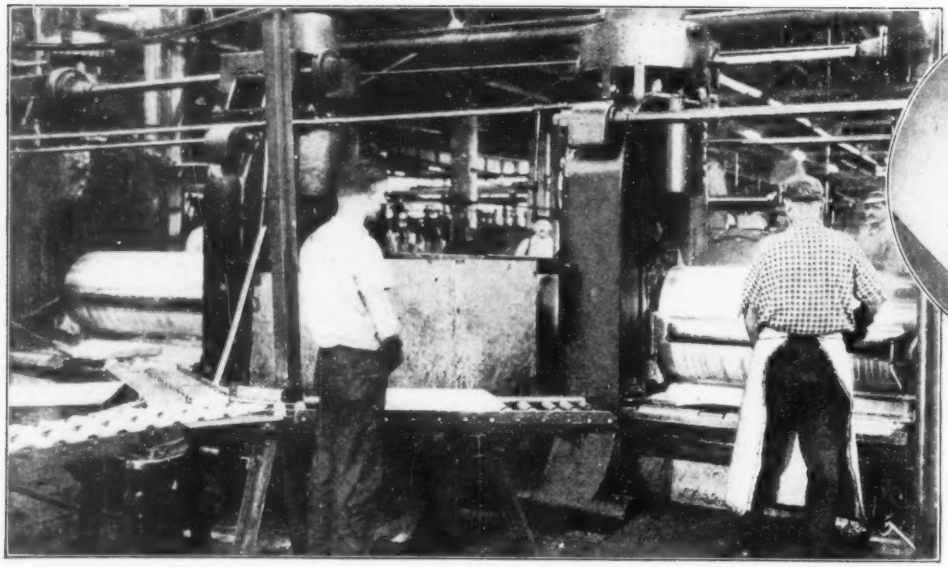
Presently Janos is dragged before Hell's dignitaries and thrust into the soul-mill. To shorten a long story the hero is thoroughly corrupted. He sins in every possible way and finally determines to kill his temptress but she eventually wins his forgiveness. Instantly Hell is thrown into a tumult.

Amid terrible noise and confusion the soul-corrupter becomes a mass of wreckage, the temptress becomes a manikin and the upright forester who is the hero returns to his humble home having experienced a whole life time in an hour.



THE INVENTOR'S DREAM IS SMASHED

The complete downfall of the machine is cleverly done, the great cylinders going down on individual elevators. The substantial runways and stairs are all mentioned in the text



BREAKING DOWN

The "pig" aluminum is recast into ingots which are reduced by "breaking down" rolls to sheets which are passed again and again through the rolls until the right thickness is attained. The illustration above shows the rough edge caused by rolling hard metal. Such edges are removed

Aluminum on Trial

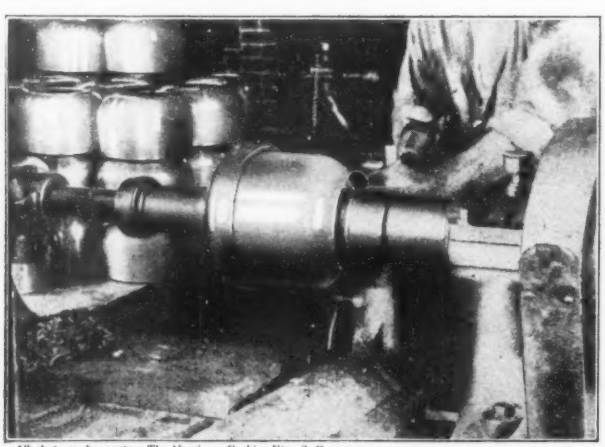
Cooking Utensils Made of Aluminum Are Shown to Have No Harmful Effects on Food

By ALBERT A. HOPKINS

THE first cooking utensils of aluminum were made in 1892 and the industry prospered with the lessening cost of the bright metal. About 1912 or 1913 someone raised a question about the use of aluminum. At that time there seemed to be nothing pernicious or persistent in the way of promoting propaganda against aluminum, but in the first part of 1926 a curious whispering campaign was inaugurated which tended to militate against the use of aluminum kitchen ware. Who started this propaganda does not seem to be definitely known but the results were and are very tangible and regrettable.

The utensils fabricated from aluminum were assailed as inimicable to health and in many a kitchen closet and garret will be found a battery of unused pots and pans made from the light material. Considering the friendly relations we of the SCIENTIFIC AMERICAN have always had with our readers, it is not surprising that we received many letters asking whether aluminum cooking utensils were harmful or harmless. At last it was determined to make a really scientific survey of the situation and the writer was assigned to examine all the evidence in the case. This involved a trip to New Kensington, Pennsylvania, one of the centers of the industry, so as to see what care is used at the mill to ensure a perfect product. This did not, of course, involve the chemical aspects of the case, but these were gathered at the Mellon Institute in nearby Pittsburgh.

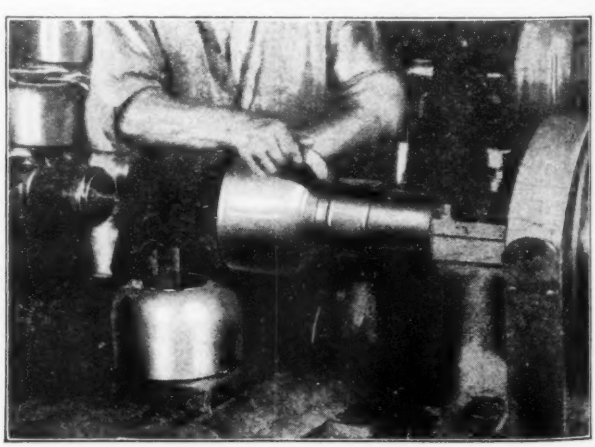
THE sum of our investigation is that there is no foundation for the belief that the use of aluminum cooking utensils is injurious. There is also no foundation for the absurd statement that aluminum or any other kind of cooking utensil has anything to do



All photographs courtesy The Aluminum Cooking Utensils Company

SHAPING A TEA KETTLE

As the top is smaller than the body diameter, the utensil first has a purely cylindrical form which is finally shaped by "spinning"

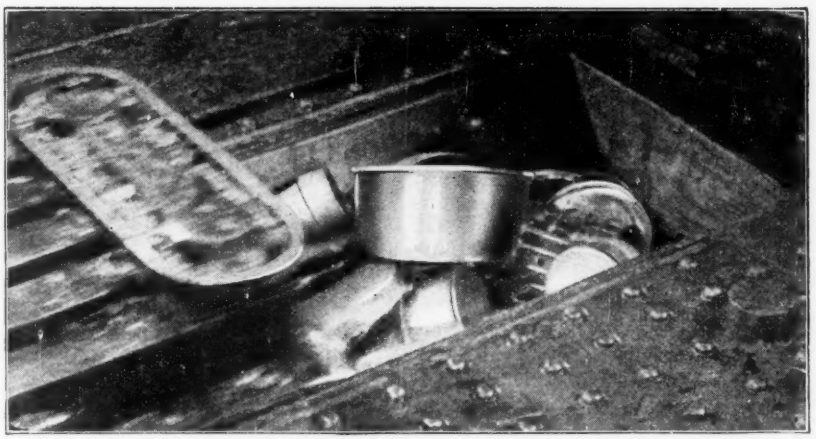


THE KETTLE IS BORN

A collapsible steel form shaped exactly like the inside of the utensil shapes the metal to its final form by heavy pressure from outside

with the causation of cancer. The American Medical Association, the United States Public Health Service, the London *Lancet* have all issued statements, or published articles which give aluminum a clear bill of health. So once and for all let us put away this bogey which should never have been discussed at all by intelligent people. Whatever or whoever may be back of the propaganda, the facts remain that aluminum has stood the test of time and today is in more universal use in hospitals and institutions than any other metal. Before proceeding to describe the processes of manufacture of the metal and the fabrication of the utensils we will consider briefly the chemical aspects of the problem.

IN 1912 the statement was advanced in England that aluminum cooking utensils were deleterious to health. The *Lancet*, the leading British medical journal, made experiments on the subject and stated editorially that this metal does not appear to be more susceptible to the action of water and foods in the process of cooking than does iron, which has been used from time immemorial as the material of cooking pans. As is well known, iron rusts very readily in the presence of water and air, while also it is attacked by organic acids. It is further well known that iron salts in large quantities are injurious to the human organism, as are also large quantities of aluminum salts, but there is no evidence to show that in the ordinary cooking operations of every-day life either iron or aluminum is so strongly attacked as to produce an objectionable amount of soluble salts. All that can be found, even when organic acids and mineral salts are present in the cooking pan, are the merest traces of metal in its soluble state. The alumina precipitated by ammonia in the tests was in practically all cases an unweighable quantity.



SCRAPPING THE IMPERFECT

On account of the hard sheet metal used, many pieces are torn or broken. The mortality of aluminum utensils is great. The "cripples" are ruthlessly scrapped by the watchful inspectors

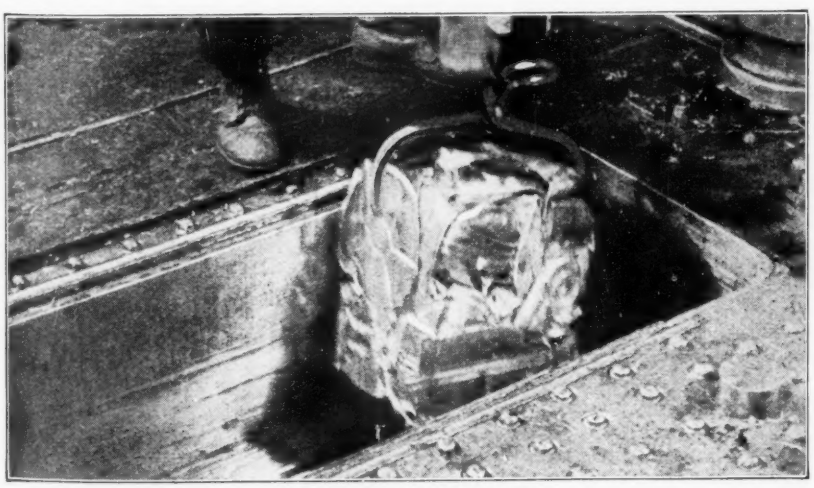
The *Lancet* states that aluminum, as it is now made by reputable manufacturers, is a suitable material for cooking vessels and that any suspicion that it may communicate poisonous qualities to food in the process of cooking may be safely dismissed in view of the results of the practical experiments which have been recorded, showing that the metal is not appreciably acted upon in cooking operations. Aluminum is also an excellent heat conductor, so that cooking in aluminum vessels is therefore rapid, and fuel is economized in consequence.

THE *Journal of the American Medical Association* states that investigations made in Great Britain under the auspices of the Medical Research Council, indicate that cooking, even of acid fruits and vegetables for long periods of time, in aluminum ware, showed so little aluminum in the juices after cooking that it required the most delicate chemical tests to indicate its presence. Indeed, not only the fruits but the actual acids themselves were boiled in aluminum ware without accumulating more than slight traces of aluminum.

Dr. George D. Beal of the Mellon Institute of Industrial Research of the University of Pittsburgh, says: "Aluminum is at the present time the most widely used constructional material for cooking utensils. During the time that it has been in use, it seems to us that the harmful nature of this metal would have become increasingly apparent to food and medical specialists. Strange to say, the only two who have found any existence of such a condition are a dentist in Toledo and an advertising physician in Chicago who has been connected with many so-called 'health institutes.'

"I have used aluminum in my home almost exclusively during the past 15 years and fail to see where the health of my family has been injured in any way. Dr. Geo. W. McCoy, Chief of the Hygienic Laboratory of the United States Public Health Service, Treasury Department, Washington, D. C., tells me that in his opinion there is no evidence to support any claims as to the harmful qualities of aluminum, and his department habitually gives an answer of this type.

"OUR own experiments as to the quantities of aluminum removed from utensils by cooking foods therein show that the quantities of aluminum removed are so small that they are not significant unless reported as parts of aluminum per million parts of food. These quantities are of the same order as those in which aluminum normally occurs in food stuffs and are in many cases far less than those observed in many public water supplies which have not been subjected to chemical treatment for purification. I mention this since the usual chemical method of clarifying water consists of the addition of aluminum and lime, and is alleged to increase the aluminum content of the water."



A "BALE" OF ALUMINUM

The damaged utensils shown in the upper illustration are forced by hydraulic pressure into a "bale" of aluminum which is picked up with tongs and remelted for fabrication anew

The *Chemiker Zeitung* in an article entitled "Aluminum Cans for Preserving Foods," says:

"The results of a large number of tests upon the preservation of various fruits and vegetables in aluminum cans are recorded. In all cases the cans were much less attacked by the fruit acids than is the tin in the usual tin-iron cans. No deterioration in the taste, color, odor, or edibility of the foods was noticed, and the very small amount of aluminum dissolved in prolonged preservation has no toxic action."

How Aluminum Kitchen Utensils Are Made

ALUMINUM has peculiar properties. It is one of the most malleable of metals, and like gold it can be drawn out into a very thin sheet or wire. This is on account of its great ductility. Under heavy pressure, even while cold, it can be pressed into desired shapes. This is called "drawing" and this operation makes the metal more dense and lustrous. This is why cooking utensils made by the drawing or stamping process are more dense and have a smoother surface than cast or molded utensils before being polished or buffed. Besides its lightness, hardness, and resistance to corrosion and chemical action, aluminum has another quality that makes it most admirable and useful for cooking utensils: this quality is the extraordinary ability of aluminum to absorb and conduct heat.

Today the manufacture of aluminum cooking utensils is a highly specialized industry employing thousands of workers who operate in huge plants. Here the product of the clay-like ore is converted into the glistening saucepan or its more complicated companion, the tea kettle, in a plant far removed from the smelter. The only ore which is really pure enough to yield metallic aluminum on a commercial scale is bauxite, of which the largest and best deposits in America are located in Arkansas. In most metal-refining plants, the metal is usually separated from the rest of the ore by the very simple process of crushing, working, and smelting, but bauxite, or aluminum ore, must be carefully refined before it can be smelted. The bauxite is shipped to East St. Louis and converted by chemical process first to sodium aluminate and then to aluminum hydrate. The white powder which is about to become pure aluminum is shipped to Niagara Falls, Massena, New York, Alcoa, Tennessee, or Badin, North Carolina, where electrical current in large volume is available at a low rate. The final reduction in electric furnaces results in the production of metallic "pig" aluminum.

ON GOES THE SPOUT

If there is a spout, this is made separately and then welded to the utensil's body

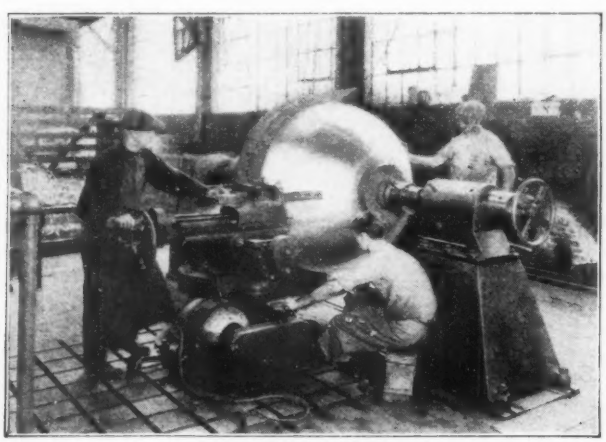
THE "pigs" of aluminum are then re-melted and cast into various forms, such as rods or ingots. The ingot is the starting point for aluminum sheets which are used in making cooking utensils. These are all made from sheet aluminum with the exception of some waffle molds, griddles, and articles produced by die casting. In sheet form it is possible to obtain hard, dense, uniformly thick aluminum utensils suitable for use in the kitchen.

The sheets are passed through gigantic rolling mills until they are reduced to the exact gage or thickness required, and during this process the metal is squeezed and compressed until it becomes dense and hard. Starting with the "blank," which is a circular or oval flat sheet of aluminum a little thicker than the final thickness of the utensil, it usually requires four or five stampings or forming operations to convert that sheet into a utensil of a straight or an inverted conical shape.

In utensils in which the top opening is smaller than the body diameter (as in a coffee pot or a tea kettle), the utensil first has a purely cylindrical form, and then is placed over a collapsible steel form shaped exactly like the inside of the finished utensil. By rapidly revolving the steel form and the partly formed utensil, while exerting pressure on the outside, the metal is shaped to the final form. The inside die, being collapsible and in several pieces, can be removed easily. If the utensil is to have a spout, this is made separately and then welded to the body. In the case of large steam jacketed kettles, the spinning operation is of great interest owing to the size of the tools required. One of our illustrations shows such an operation.

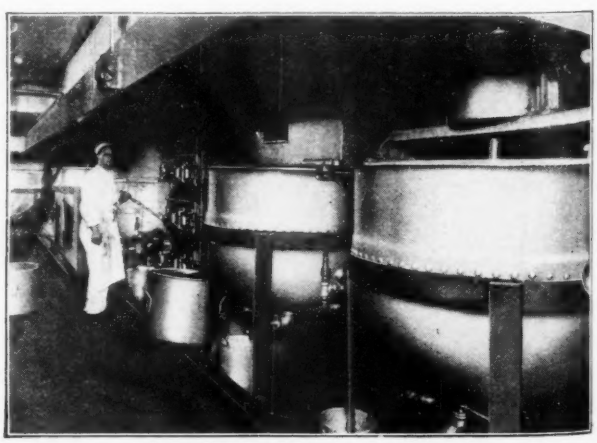
IN the process of manufacture from cold, hard, sheet aluminum many pieces are cracked and broken and are discarded and melted up as scrap aluminum; only perfect articles may pass to the kitchen closet.

So the interesting story of aluminum ends. From every viewpoint, lightness, economy in first cost and economy due to extremely long life, economy in fuel due to superior heat conducting and heat retaining qualities, and finally in safety from all harmful action of food acids, aluminum utensils for cooking are in keeping with the modern, progressive and scientific spirit of the 20th Century.



SHAPING A KETTLE

Aluminum spinning on a vast scale. Very heavy machinery is required to produce the shell of a modern steam jacketed kettle



ALUMINUM GOES TO WORK

Here we have great steam jacketed aluminum kettles making soup for canning. No metal is better adapted for this purpose

Seeking the Secrets of Lightning

TO obtain "autographs" of lightning flashes and analyze them so that power transmission lines may be protected and interruptions of service prevented, investigations have been carried out for several years. In this country, the Westinghouse Electric and Manufacturing Company established in the summer of 1928 an outdoor lightning research laboratory consisting of two stations about five miles apart on opposite sides of the exposed end of the Chilhowee Ridge in the Great Smoky Mountains of eastern Tennessee. Records indicated that lightning is as severe and frequent in this locality as anywhere in the country. Also, a highly insulated power line runs over the ridge. The Aluminum Company of America and the Knoxville Power Company, owners of the line, co-operated fully in the plan and in the work of establishing the stations.

Chief among the instruments used in these stations is the cathode ray oscillograph developed by Dr. Harold Norinder of Sweden. The difficulty of using the usual type of oscillograph in lightning studies lies in the fact that the discharge lasts but a few millionths of a second and may occur at any time. Therefore scientists sought a relay which would turn on the oscillograph in less than one 100,000th of a second before the arrival of the lightning in order to prevent the fogging of the photographic film which would occur should the stream of electrons be permitted to strike the film in one spot for even that short period of time. Dr. Norinder modified the oscillograph itself so that no relay is necessary.

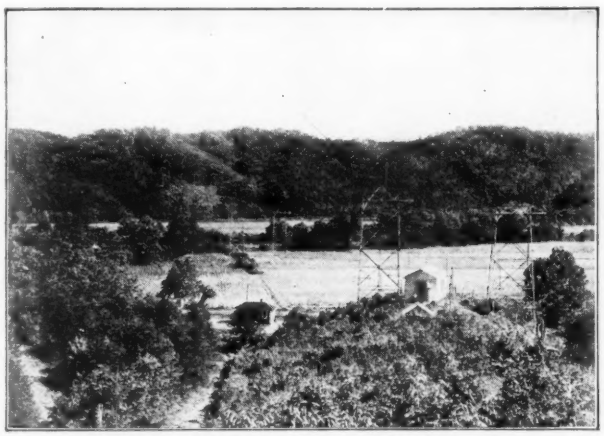
A Norinder oscillograph is located in each station and each is supported by klydonographs in the line on both sides. Microphones on each side of the stations are used to determine the location of the discharge by the noise of the thunder and an osiso is used to record the time difference between these and an antenna, at each station, which records the electrical disturbance. Cameras with "fish-eye" lenses are used to obtain photographs of lightning in any part of the sky.

Electrical storms were singularly rare during the summer of 1928 after the stations were established and only one flash was recorded and this reached a maximum of only 650,000 volts. The curve registered by this flash showed that it disappeared 50/1,000,000ths of a second after it began, having risen to its maximum in a few millionths of a second. The records obtained show everything necessary for a full analysis.

Mr. Atherton, an engineer of the Westinghouse Electric and Manufacturing Company, says that the knowledge gained from such studies of lightning "are of tremendous value to scientists striving to combat lightning. If reports come in from a hundred investigations in a hundred localities, then, and only then, can we hope for final victory over our ancient enemy, and the consequent benefits of cheaper, more reliable, and more abundant power." It is expected that the investigations will be continued in 1929 with, it is hoped, greater success.

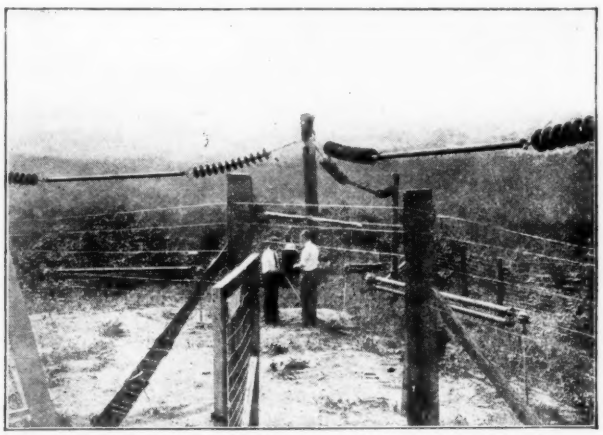
THE POWER LINE'S ENEMY

A blinding, powerful flash such as this, striking power lines, may interrupt service and rupture machinery



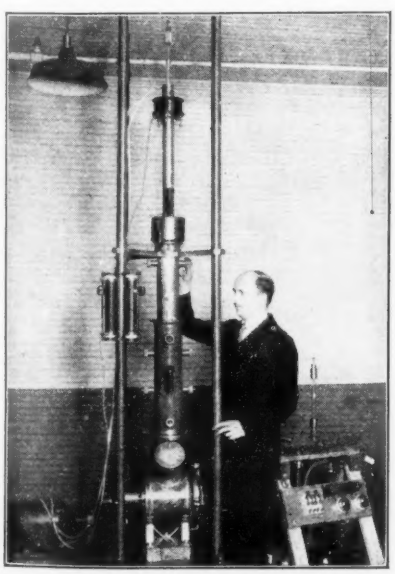
WHERE LIGHTNING IS PREVALENT AND SEVERE

One of the lightning study stations on a knoll of the Chilhowee Ridge in the mountains of Tennessee. Note the transmission line



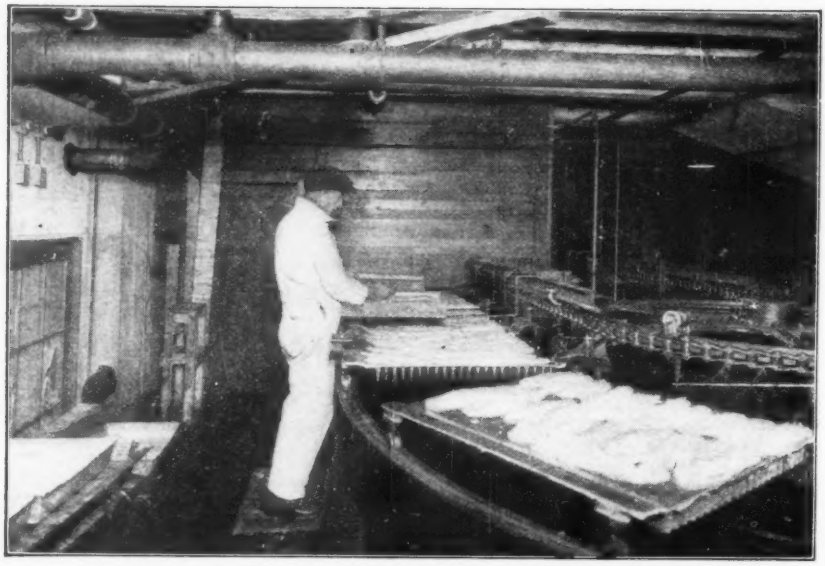
CHANGING THE FILM AT A KLYDONOGRAPH STATION

The klydonographs supporting the Norinder oscillographs verified the maximum voltage record of the latter instruments



THE NORINDER OSCILLOGRAPH

The instrument which made practicable the lightning studies undertaken last year



QUICK FREEZING OF FISH FILLETS PRIOR TO SHIPPING

In this automatic freezing machine, the plates are of aluminum with deep ribs extending downward. These dip into calcium chloride brine at about 20 degrees below zero, Fahrenheit

Science In the Distribution of Fish

One Of Man's Oldest Industries Rejuvenated By the Adoption of Scientific Methods

BY HARDEN F. TAYLOR
Vice President, Atlantic Coast Fisheries Company

FISHING is one of the oldest pursuits of man. Archeologists tell us that crude implements found among the relics of ancient man testify to their capture of fish food with such things as hooks made of thorns and splinters of bone, spears, crude traps and weirs, and even harpoons. In the centuries preceding our scientific civilization, the arts of catching fish with nets, and preserving them by salting, smoking, and drying were slowly developed. We who are in the industry may as well admit that even after scientific research had revolutionized many other industries, the fisheries were still extremely slow in grasping the opportunity of applying scientific method to the solution of their interesting problems, for even now some of the methods of salting and smoking are followed that were being practiced when Shakespeare was writing his plays and Walter Raleigh was trying to colonize Carolina.

The use of ice as a temporary preservative for fish is less than a hundred years old. Canning salmon, sardines, oysters, and a few other fishery products came with the development of hermetic canning of other foods, and the application of artificial refrigeration came into practice. But all of these things were forced on the fisheries from without rather than developed by initiative. Very little indeed was done by fisheries people themselves to originate new things of their own.

All this is now rapidly changing; new and important advances are coming about in the fisheries to such an extent that they constitute news of technical progress. This revolution may be an outgrowth of the increased demand for food occasioned by the World War, or, more likely, it is the eventuation of what must unavoidably have come to pass sooner or later—the realization of the immense spread of ocean, with its unlimited store of raw materials and vast receipts of sunlight for the photosynthetic production of food, the suitability of that food for human needs, and the growing demand for food by increasing populations.

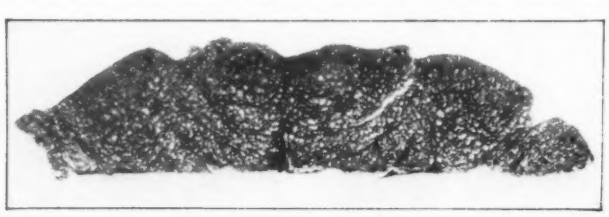
The problem of the fisheries has always been that of getting fish to the consumer in first-class condition. Everybody who goes fishing knows the delicious palatability of the fish he catches, if they are cooked and eaten promptly. And yet at home he does not particularly care for fish, especially if he happens to live a few hundred miles from the sea.

A TRADITION has grown up in many places that fish are to be eaten only in months the names of which contain the letter R, not because the fish are any the less edible or nutritious in summer than in winter, but merely because the technique of delivering it in good condition had not been perfected until recently. Furthermore, in the old-fashioned way, the entire fish, 60 percent or more being inedible and disagreeable, was shipped.

A secondary, but grave, difficulty has existed in the great inequalities of supply and demand, causing gluts of great amounts of highly perishable food at times, and at other times a great shortage and high prices. The fisheries industry could never occupy its proper place as a food producer until these two problems were solved.

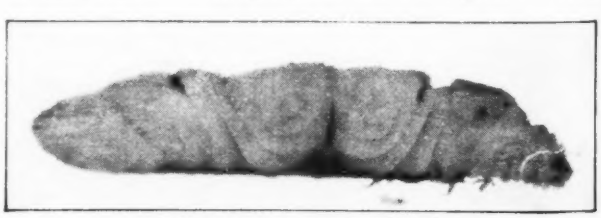
The new system, built by scientific research, is rapidly solving these problems by changing the whole system of handling fish, introducing not only modern methods, but some novel creations and processes originated by the industry.

The fundamental development in this field is in refrigeration. It has been found that there are two kinds of decomposition in fish—bacterial and autolytic or self-digestive. A temperature of 32 degrees arrests



SLOWLY-FROZEN FILLET

In the old process of freezing fish for many hours, large ice crystals formed in the flesh and ruptured it as shown in this cross-section



QUICKLY-FROZEN FILLET

By the new process, fillets of fish are frozen in about 40 minutes, the result being that ice crystals formed are of minute size

neither, but merely retards them. To arrest them, much lower temperatures are necessary—but this necessitates freezing. It has been found that at temperatures around zero, Fahrenheit, freezing stops all chemical and bacterial change. But frozen fish are supposed to be inferior. Is this supposition well founded, or not?

The answer to this question lies in both the purpose and the technique of freezing.

In the older industry, when serious gluts occurred, the producers, struggling to save their fish, would freeze them to prevent total loss. It sometimes happened at such times that the fish were frozen after they had lost some of their original fresh quality. This practice of freezing fish that were already stale gave to the consumers the erroneous idea that the freezing itself was the cause of poor quality of the frozen fish.

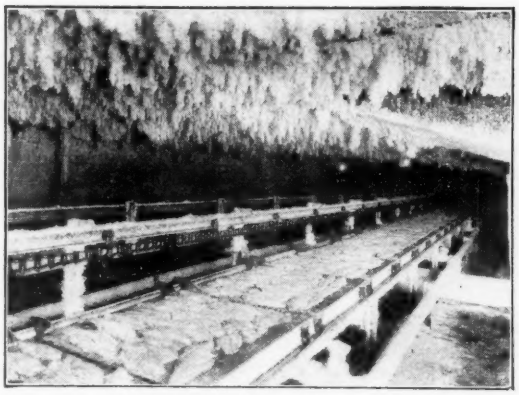
Furthermore, research has shown that the technique of freezing could be greatly improved so that, with perfectly fresh fish to work upon, a practically perfect quality could be delivered to the distant consumer. The older method of freezing consisted in putting the fish in a cold room and allowing them to freeze slowly.

During this freezing, the water in the fish (about 75 to 80 percent) is converted from liquid to solid, the solid assuming the form of ice crystals.

NOW we know from physics that, in slow crystallation, the crystals are large in size and few in number, while in rapid crystallization their number is great and the size small. In slowly frozen fish, therefore, the ice crystals are so large as to rupture the cell membranes and muscle fibers. The writer has pulled crystals an inch long from slowly-frozen halibut.

The resulting damage to the fish has the same effect as a bruise to an apple—the fish rapidly deteriorates when it is de-frosted. This difficulty is overcome by applying refrigeration so rapidly that such crystals as are formed are microscopic or sub-microscopic in size. When fish are frozen as rapidly as this (40 minutes as compared with 24 hours or more by old methods) it may be defrosted and no difference from fresh fish will be noted either by the eye or by chemical methods. It will have the same edible qualities as fish just out of the water. Such freezing does no more harm to the fish than it does to ice cream.

Other difficulties were encountered, however. A living fish, like any other living animal, is an extremely complex chemical laboratory where a great variety of chemical reactions are taking place. When the fish is alive, the reactions are controlled and in equilibrium. When it dies, some of these reactions go right on, uncontrolled, to the detriment of the fish flesh. For example, just as the pepsin in the stomach will digest the stomach itself if the blood supply is stopped, so the enzymes and secretions of the fish, when circulation of blood is arrested by death, proceed to act on the tissue themselves and decompose them. Because of these facts, even when the fish is quickly frozen, after a short while the body juice begins to separate from the fiber, and the whole turns a yellowish color. It was found that these uncontrolled reactions could be arrested easily and simply once their chemical nature was understood.

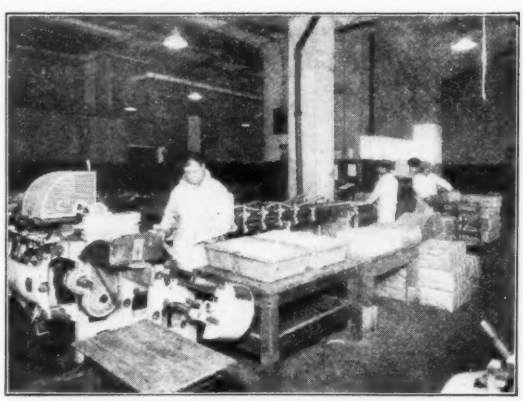


MOVING FREEZER PLATES

Fillets on plates of conveyor, freeze in about 35 to 40 minutes. Room temperature is well below zero

THE result of all these discoveries is fish flesh equal to fish just out of water, but able to endure in its original condition while it is being transported inland.

But to perfect such a fish for the modern home it is imperative to remove all waste parts (for the manufacture of by-products); to enclose the boneless edible flesh, after it passes through the automatic and continuous freezing process, in a sanitary package; to provide refrigerated transportation to distant cities; and to provide means for holding it frozen in the retail store until it is taken home by the consumer. Then if it is put into the oven still frozen, this is the assurance that it is still in prime condition.



PREPARING FILLETS FOR SHIPMENT

Automatic wrapping machine wrapping fillets of fish after they are frozen. They are packed in paraffin paper and shipped in special refrigeratar cars

The chain of events from the bottom of the sea to the consumer's table is as follows: Fish (principally haddock) are taken from the Atlantic Ocean at Cape Cod by giant trawls, or funnel-shaped nets dragged by steel steamships or trawlers, and iced down until they arrive at port. From 100,000 to 250,000 pounds are brought in each trip. The fillets (clear strips of meat) are immediately cut, and frozen on an automatic, continuously-operating freezer, maintaining a temperature of 15 degrees to 25 degrees below zero, the fillets resting on aluminum plates. Each machine freezes 25,000 pounds, or a carload a day.

THE frozen fillets are now skinned and conveyed to automatic wrapping machines, each of which wraps 30 packages a minute in paraffin moisture-proof vegetable parchment. These individual packages, each containing one fillet, are packed in impervious containers and conveyed to a cold room where the temperature is near zero, Fahrenheit. From this room, cars are loaded.

The cars are an interesting feature of this system and are worth a few words of description here. The usual ice-and-salt refrigerator cars scarcely maintain sufficiently low temperatures in warm weather to carry the fillets frozen, hence a new car has been adopted.

This car is refrigerated by an absorption system, in principle very similar to the familiar ammonia absorption system, but adapted for automatic operation on freight cars. Fuel gas liquified in a tank suspended under the frame of the cars is used for direct heating of the generators. A condenser is mounted on the roof. The cooling evaporator pipes are mounted lengthwise on the ceiling inside the car.

Instead of ammonia, sulfur dioxide gas is used as the refrigerant. This gas, being completely oxidized, is stable, and is not subject to the decomposition that occurs in ammonia. Non-condensible gas does not accumulate in sulfur dioxode. Sulfur dioxide also has the advantage of lower operating pressures than those of ammonia.

THE SILICA GEL REFRIGERATOR CAR

The new type of car in which frozen fish are shipped. No ice is necessary, since the car contains its own refrigerating equipment which is automatic and maintains a low temperature

In the ammonia absorption system, water is used as the absorbing medium. In the Silica Gel system, Silica Gel is used as the absorbing medium. This substance, being solid, cannot be pumped. The vessels in which it is contained are, therefore, alternately heated and cooled, serving as generators while they are being heated, and as absorbers while they are cooling.

SILICA GEL is a relatively new substance to industry. Chemically it is hydrated silicon dioxide. It is made from sodium silicate, or water-glass, by the addition of sulfuric acid. Upon the addition of the acid the silicate forms a jelly, sodium sulfate being formed simultaneously. This jelly is washed free of sodium sulfate, broken into pieces, and dried. The broken and dried Silica Gel is screened into pieces of uniform size, the granules having the appearance of broken glass or gum arabic. The most conspicuous property of Silica Gel is its marked absorbent property—or more properly, "adsorbent," the word used by physical chemists for this particular type of absorption. The Gel has an immense surface in the pores of its structure (ultra-microscopic in size) which gives it an amazing adsorbing power. It will adsorb 35 percent of its weight of sulfur dioxide gas, and give this gas off again when the Gel is heated, the Gel itself remaining physically and chemically unchanged throughout the cycle of adsorption and generation.

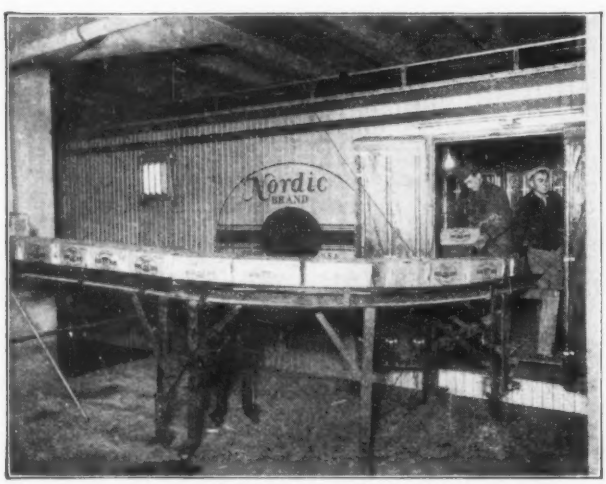
In the cars, the Silica Gel is contained in vertical steel tubes, 400 such tubes being one unit, and four units being used—two heated as generators and two being cooled as adsorbers at any particular time. When a saturated unit is being heated, a check valve cuts it off from the evaporator and another opens to the condenser.

These cars have been in operation several months and have operated perfectly. The temperature can be brought to zero, Fahrenheit. A fuel gas supply tank is located at the fillet plant at Groton, Connecticut. The tanks of the car are filled and the apparatus set going to pre-cool the cars which, upon being loaded, are sent out set for a temperature of 15 degrees to 20 degrees, Fahrenheit. These temperatures are maintained regularly on the entire trip. Numerous cars have been forwarded to points in Texas and other southern states with entire success and one has gone to San Francisco from Groton, Connecticut. Its temperature on arrival was 17 degrees, Fahrenheit. Another is at the time of this writing *en route* from Groton to Los Angeles, California.

Arriving at their destination, the boxes of frozen fillets are placed immediately in cold storage rooms at a few degrees above zero, Fahrenheit. From here, they are delivered by refrigerator trucks to retail stores. Electric refrigerators are being installed to hold the fillets in stores until they are sold. These refrigerators keep the fillets at from 15 degrees to 20 degrees, Fahrenheit. Solid carbon dioxide ("dry ice") is also being used to some extent for retail store refrigeration.

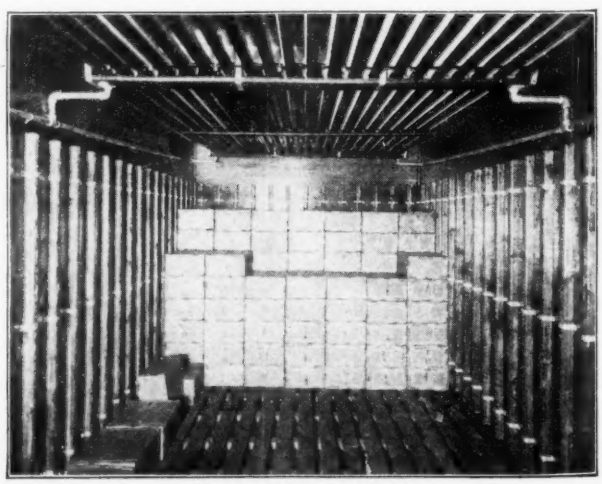
This system of preparation and distribution accomplishes its primary purpose of delivering fish at distant points in the same condition they were in when landed at port.

AS secondary advantages, it enables all grocery stores to sell fish without smell or mess. It enables them to stock fish all the time instead of Fridays only, without danger of loss. It assures a supply of fish in summer (when, of all times, fish is most suitable in the diet); it provides a clean, protected sanitary piece of sea food, which is 100 percent edible, and all at about the same price as would be paid for the edible portion of ordinary whole fish. This is made possible by utilization of waste for by-products, labor-saving machinery, carload freight instead of express shipment, and efficient mass production.



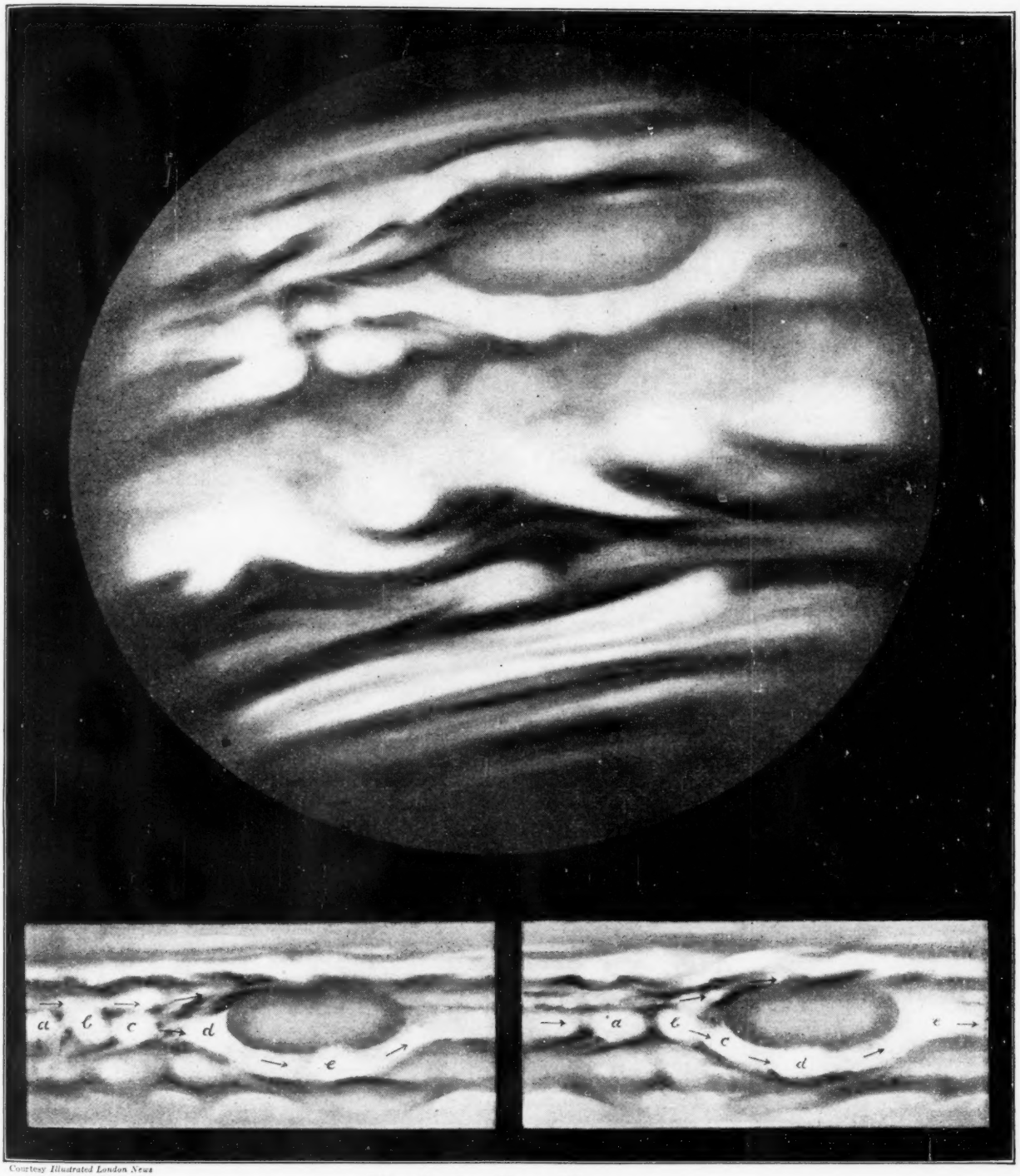
LOADING A CAR

Neat, dry packages of fillets being loaded into a Silica Gel refrigerator car. Shipments have been made over long distances



READY FOR COOKING

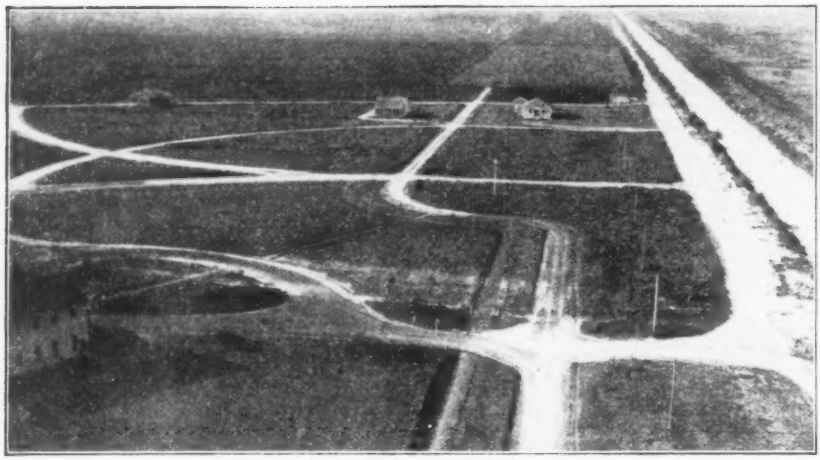
Fillets frozen and packed at the plant are shipped to the destination, and are kept in refrigerators until finally sold to consumer



Courtesy *Illustrated London News*

The Jovian Face Changes

EVEN six-inch reflecting telescopes like those so many readers of this journal have made in recent months will reveal the ever-shifting belts and semi-permanent markings of Jupiter, but the drawing shown above was made with the aid of a 24-inch reflector, by Mr. Scriven Bolton, a British amateur astronomer. Jupiter's face always provides plenty of variety to those who follow the planet's moods from month to month. The visible markings have undergone unusual activity within the past year or two. "One of the most remarkable disturbances ever recorded on Jupiter," says Mr. Bolton, "is now taking place in the vicinity of the well-known Great Red Spot." This disturbance covers an area 12 times—the Spot 70 times—that of the United States. The disturbance is overtaking the Spot. "Deviated from their course," Mr. Bolton explains, "the white and dark spots of the disturbance are seen to skirt around the shores of the Spot. . . . Lighter vapors can occasionally be glimpsed actually passing over the Spot itself, only to fade away in a few hours." Dr. W. H. Wright of Lick Observatory has photographed Jupiter in ultra-violet light and in red light, the former showing the upper atmosphere, the latter a lower level. The Red Spot shows in the upper layer. It is also believed to reach through to the actual surface of the planet.



NEW HOLLAND, A LAND OF CANALS

An airview of part of the drained district in North Carolina, showing the central canal, the layout of the town site of New Holland, the network of roads, and farms in the background

Drained Tract Is New World Netherlands

Lake and Land Below Sea Level In North Carolina Is Reclaimed For Farming

By G. S. CARRAWAY

THE success of what is said to be the largest drainage pumping plant in the world, located at New Holland in North Carolina, as proved last fall by the efficiency of the big pumps during record wet weather, is listed as one of the outstanding engineering and industrial events of the period.

This mammoth pumping plant has drained effectively 100,000 acres in eastern North Carolina, including 50,000 acres of Lake Mattamuskeet and 50,000 acres of adjoining territory. Where recently stood water and bullrushes are now thriving farm crops.

IN the lake site that was under water a few years ago, 4000 acres are now being cultivated successfully, with 5000 additional acres marked for cultivation by next fall. What is probably the largest soy-bean field in the world—covering 1400 acres—bears witness to the rapid progress made during the last three years on this great project.

Lake Mattamuskeet covered 48,000 acres of land a few years ago. It was shaped like a saucer, had no outlets, was three feet below sea level, and was six miles wide by 18 miles long. With no natural drainage, this large section of land was very marshy, but rainfall also caused much trouble, since as much as 60 inches often fell there in a year.

For 20 years various individuals and firms have been endeavoring to drain the land successfully so that it might be used for crops. Several companies failed, one being probably the first and only drainage company to go into a receivership. Some promoters drew monetary losses and prison terms for attempting to sell the land there on promises.

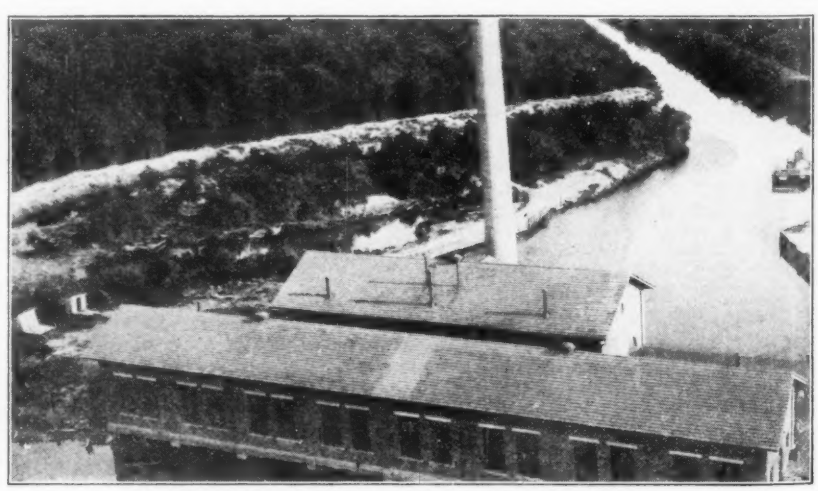
The New Holland Corporation was organized in 1925 by August Heckscher, millionaire real estate dealer of New York, who had decided to purchase the tract from the receivers and try to drain and develop it for farm crops. An investment of 1,500,000 dollars has been made by Mr. Heckscher in this development of which D. N. Graves, of Winchester, Massachusetts, is general manager, and B. M. Potter, of New Bern, North Carolina, is chief engineer.

Mr. Graves had been one of the first outsiders interested in the site. His way, however, was beset with difficulties and opposition. Doubters, knockers, and pessimists said that the work could not possibly be done successfully. Nevertheless, he worked tirelessly, supervising all phases of the vast and unusual work, heedless of opposition and unafraid of difficulties. For two years he kept five floating dredges at work. The sum of 365,000 dollars was spent in cleaning the old canals that had been dug by previous engineers.

WITHIN less than three years the land is being developed successfully and splendid crops have already been grown on part of the land. In addition to the 48,000 acres owned by the company, 51,000 acres of privately-owned land comes within the drainage district. Even the most pessimistic doubters are beginning now to admit the permanent success of the proposition.

The site is still the scene of great activity, as additional acres are being cleared and developed by the 500 or 600 men who are still working on the big area. Most of these workmen are employed in ditching. Records of all costs and results obtained are kept carefully. Operations are carried on both day and night, 27 tractors being equipped with headlights for night work.

Crop experiments were started in 1927 and excellent results obtained,



PUMPING STATION AND OUTFALL CANAL

Pumps in this plant lift the water about 15 feet from the central drainage canal to the outfall canal through which it runs by gravity seven and a half miles to the sea at Pamlico Sound

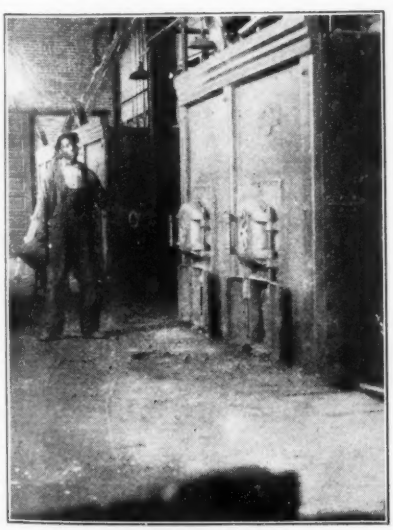
the following being examples: 50 bushels of soy beans to the acre, 960 bushels of sweet potatoes to the acre, and 35 bushels of wheat to the acre. The 1928 averages are even a little higher over wider ranges. Duroc hogs are raised successfully on the tract and much garden truck is grown by native New Hollanders. Two crops are planted annually on the same ground.

This unusual agricultural record is due to the success of the drainage pumping plant. A million gallons of water can be lifted and pumped each minute. There are four centrifugal Corliss engine steam pump units, each having a capacity of 250,000 gallons of water per minute. Eight miles of water barrels could be filled within one minute by these pumps, it is estimated.

USUALLY it is necessary to operate only one or perhaps two of the pump units, depending on the amount of rainfall and surface water, and it seldom is necessary for them to operate full time. All the canals on the big tract could be pumped dry, if desired, within a day. Four boilers, each of 3000 horsepower, are used. The unit cost for draining the entire district is said to be one dollar per acre each year.

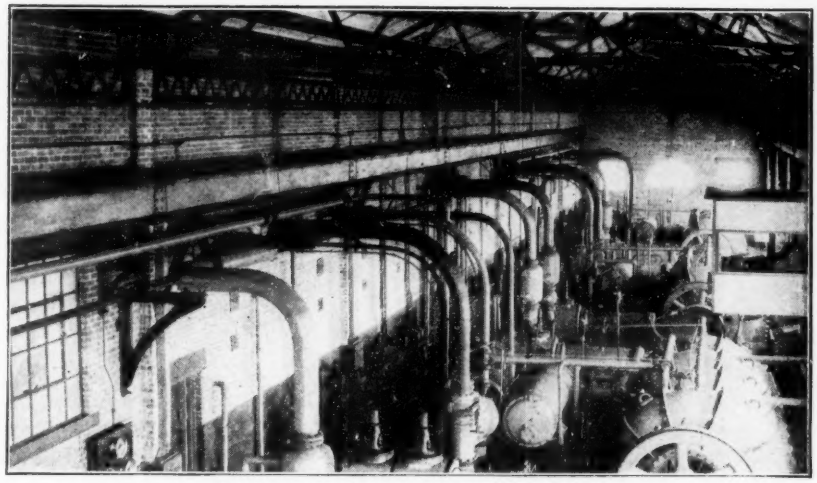
This system of drainage is accomplished by the use of culverts on the land, which drain to the ditches and canals. On every 1000 acres under development there are 50 miles of ditches. There are 100 miles of canals, one and a half miles apart, each from 20 to 100 feet wide.

The drained water is lifted almost 15 feet by the pumps and carried through big pipes in the plant to the outfall canal, which extends seven and a half miles to Pamlico Sound. The water thus flows by gravity down to the sea.



BOILER ROOM

Four coal-fired boilers at the station supply steam to the four pump engines



INTERIOR OF THE PUMPING PLANT

Four pumping units in this plant have a combined capacity of one million gallons of water a minute. They have proved capable of handling great floods during the wettest seasons

That the pumps are working successfully was proved during the summer and fall. A record rainfall of 27 inches fell during July, August, and September, 1928. Of this amount, 12 inches came during September. Despite this heavy rainfall, when other parts of the county stood many inches under water, the drainage site sustained no damage.

The development and town at New Holland are remarkably attractive. Plans for the place were drawn by a landscape gardener. Silver leaf poplars and other trees have been planted there in numbers, and shrubbery and flowers have been raised in profuse beauty during the last two years.

Where water stood a foot deep some years ago, there is now a picturesque inn, with a Dutch motif carried out in the decorations and equipment. Besides being a land of canals, the settlement actually bears a striking resemblance in other ways to old Holland, thus accounting for its name.

THE town has a water system, electric light plant, streets, and sewers. During the last year, 25 miles of roads have been constructed on the tract. A 35-mile railroad connects with outside railroads.

The project has cost much money but Mr. Heckscher is not interested in profits. Although he has visited the site only once, he is enthusiastic and eager to make the project unquestionably successful. That he has been able to obtain splendid results so far in a comparatively short time is evidenced by the fact that Florida drainage experts have visited the spot to study the methods of work at New Holland.

Such drainage schemes are expensive and difficult but they have some advantages over forest areas intended for agricultural purposes. There are no trees to be cut down or stumps to be dug; and the level, flat land and the deep, rich soil are easily adapted to quick machine cultivation. The 10-acre tracts may be rapidly ditched, bridged, drained, and connected by roads, and quickly put into proper condition for plowing and planting.

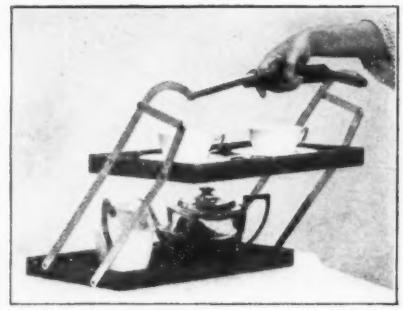
In the main part of the big drainage pumping plant is an inscription, written by the Mattamuskeet Drainage District Committee, which indicates the purposes and advantages of the mammoth, unique drainage scheme in North Carolina. It reads as follows:

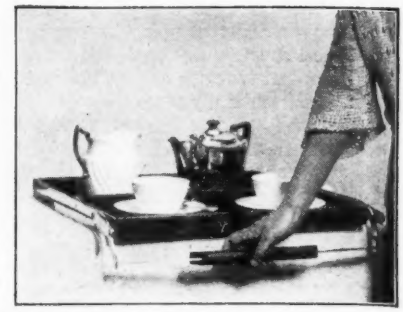
"THIS plant is dedicated to the spirit of co-operation, which has here transformed the great lake into dry land and so created a new and fertile principality for the use and possession of man.

" 'And he gave it for his opinion that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before would deserve better of mankind and do more essential service to his country than the whole race of politicians put together.' — *Daniel Defoe.*"

While the New Holland drainage project is perhaps the greatest unit system of its kind ever to be put into operation in this country, there are other immense tracts of swampy waste land throughout the United States where similar methods of reclamation might be used to great advantage. Notable among these is the area generally known as the "Jersey Meadows," many thousands of acres in extent, and now covered with bull-rushes. The Jersey Meadows are close to the center of the New York metropolitan area, are bordered by a rich industrial development, and lie along the Passaic River which runs between the west shore of the Hudson River and Newark, New Jersey, and its surrounding group of cities. Previous efforts to reclaim this land have been by filling.

Household Helps





FOLDING SERVICE TRAY CARRIED WITH ONE HAND

An English manufacturer presents this collapsible folding tray, which folds flat on the table or can be converted into a two-tier tray by simply lifting the handle. It is light and well balanced, and designed to be carried with only one hand. *Besway Manufacturing Company, The Green, Stratford, London, E 15, England*

NEW COFFEE URN

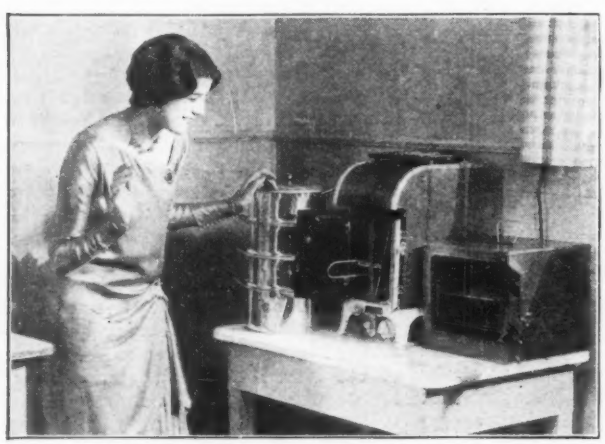
This handsome little urn makes coffee without brewing it. It has two compartments and two faucets, one for hot water and the other for coffee. The water is electrically heated, syphoned over the coffee grounds, and then accumulated as coffee. *Thomas A. Edison, Inc., Orange, N. J.*

IMPROVED BED SPRINGS

Unusual construction makes it possible to roll and carry this combination mattress and bed spring. It is light in weight, and is so designed that the heavy cover can be removed with ease, whenever it is desired to wash it, or clean the springs. *The Karr Mfg. Company, Holland, Michigan*

SCOURING DEVICE

This rubber covered steel-wool brush is designed to save wear and tear on the hands when scouring kitchen utensils. The steel wool contains a chemical designed to make it particularly effective for cleaning and polishing aluminum ware. *Whiskette, 3240 North 13 Street, Philadelphia, Penn.*



TASTY STEAKS WITH LESS SMOKE

In this electric broiler, the natural juices of meats of all kinds are sealed in tight, eliminating loss in flavor and weight in the drip pan, as well as the customary smoke. *Screlco, Incorporated, Graybar Building, New York City*

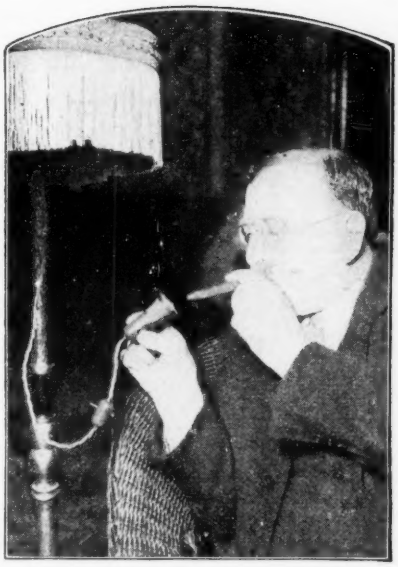
SMALL WASHER FOR SMALL FAMILIES

This little electric washing machine is designed for use in small homes or apartments. It weighs only 20 pounds and can be placed on any small table, or in the bathtub. *Handi Appliance Corporation, 11 West 42nd Street, New York, N. Y.*

Inventions New and Interesting

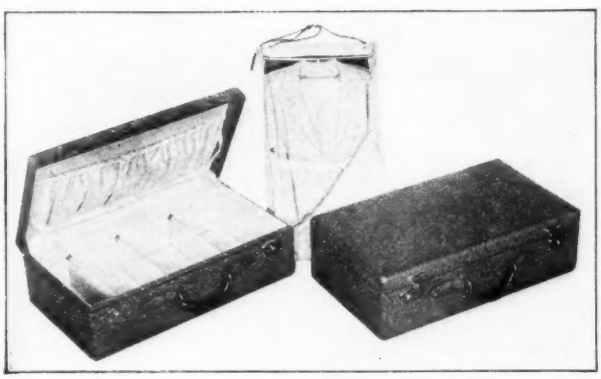
← SINGLE-LEG TABLE

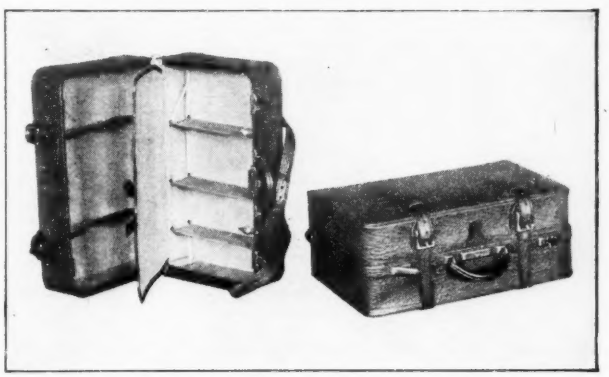
The comfort of your favorite easy chair can be enjoyed while using this table. It has just one leg, but when placed on an arm chair it is quite firm, and is adadjustable to the desired height.—*Solitaire Table Company, Old Saybrook, Conn.*



LAMP SWITCH AND LIGHTER →

This cord has one switch to control the lamp and another to operate an attached cigar lighter. Arm chair addicts and those who like to read and smoke in bed will appreciate it.—*A. W. Franklin, Inc., 11 W. 42nd Street, New York*



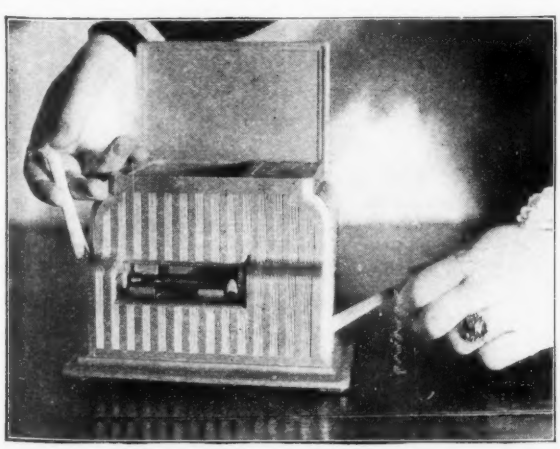


COLLAPSIBLE PARTITIONS DISTINGUISH NEW LUGGAGE

Keeping any semblance of order in old fashioned luggage is something of an art. These new bags make it easy to follow the old rule, "A place for everything, and everything in its place." The partitions can be folded flat when space is needed for large articles. By using the tray over the partitions, and the hangers and envelope, garments can be moved without fear of dust or wrinkles.—*Western Grip and Trunk Company, Milwaukee, Wisconsin*

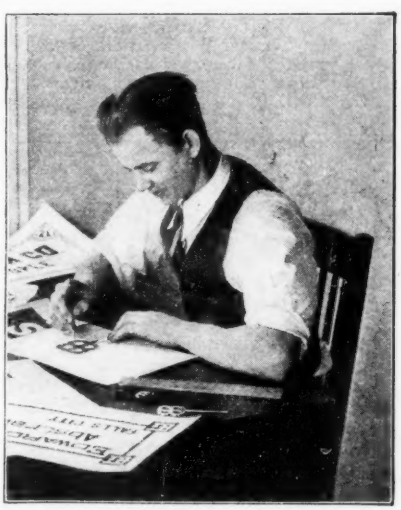
SLIDE RULE COMBINED WITH MECHANICAL PENCIL

This mechanical pencil, made of metal-mounted Bakelite and slit so that the two segments slide longitudinally, combines a thin-lead pencil with an accurate and convenient slide rule.—*Ruxton Multi-Vider Corporation, Graybar Building, New York*



HUMIDOR LIGHTER

This addition to the smoker's equipment automatically presents a lighted cigarette, by just pressing a lever. When the lever is depressed, a cigarette drops into the opening at the front, and the lighter is ignited by the familiar "spark-wheel and flint" principle. When the lighted cigarette is removed, the lighter is extinguished.—*Blake-Clarke Company, 522 Fifth Avenue, New York City*



LETTERING KEYS

Amateur sign painters and others can lay out perfect letters and numerals with this tool.—*Consolidated Sign Letter Company, 73 West Van Buren Street, Chicago, Illinois*

Learning to Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

Airplane Design Competition

WE are very happy to announce that, thanks to the generosity of Colonel R. Potter Campbell of the American Cirrus Engines, Inc., a prize of $500 will be offered by the SCIENTIFIC AMERICAN for the best design of a light plane which is submitted before October 1, 1929; the design called for to be one which is specially adapted to the needs of the private plane owner.

The committee of judges will comprise Miss Amelia Earhart of Atlantic flight fame; Mr. George Palmer Putnam of Putnam and Sons, a private plane owner; and Prof. Alexander Klemin of the Daniel Guggenheim School of Aeronautics, New York University.

Competitors will be required to submit to the committee a description of their design and preliminary calculations with drawings illustrating accommodations for pilot and passenger, and drawings illustrating the installation of the power plant, together with drawings and sketches showing the general structure of the plane. Full particulars of the competition, together with data on the size and type of engine around which the plane is to be designed, will appear in the next issue of the SCIENTIFIC AMERICAN. The competion will be free to everyone in the United States, and it is believed that it will tap a wide source of design and engineering skill.

A New Type of Landing Field

GAVIN HADDEN, a New York engineer, has designed a new type of landing field which has some interesting features. For runways of a given length in all directions, a field in the shape of an equilateral triangle, with this runway length as its altitude, will occupy the smallest possible area of ground.

If instead of merely having equilateral triangle, the equilateral triangle is bounded by three circular arcs each described about an apex of the equilateral triangle, with radii equal to the side of the triangle, certain further advantages accrue. It is now possible to lay down runways of equal length in all directions. The drawing shows a 12-way system, with runways at uniform intervals of 30 degrees.

Mr. Hadden estimates that with runways 2500 feet long, this system would require about 18,000 square yards less than the familiar circular system of runways with all intersecting at the center. The saving is of course due to the 15 separate and complete intersections, where the paving of one runway serves for the runway of an intersecting runway. If a "triarc" landing field is placed within a square, it is possible to swing the landing area proper in such a way as to avoid topographically unfavorable sections of the terrain. It remains to be seen whether this theoretical conception will be followed in practice.

Dinghies for Flying Boats

THE British are a sea-going people and many picturesque sea terms are in common use with them, which rarely appear in American speech. "Dinghy" is one of these interesting words and it is certainly more striking than merely "small boat." Small boats of various kinds have been tried out on seaplanes by our own navy, but it is interesting to have the views of an English authority, Flight Lieutenant B. C. H. Cross, who discusses dinghies in part of a paper presented before the Royal Aeronautical Society. His opinion is that at the present stage of development, it is doubtful whether the additional load of a small boat can be justifiably added to the already overburdened seaplane. In practice the surplus carrying capacity which can be allotted to a dinghy is so restricted that it appears impracticable to build one suitable for operation in anything but the calmest water. If it is regarded as a raft for use in emergency and to replace the weight of flotation jackets for the crew, it would be hardly justified. Lieutenant Cross considers it more economical of weight to develop a combined floating and flying suit, or to utilize inflated cushions, in the case of a commercial service flying boat.

Since the design of such boats may engage the attention of American inventors and designers, it may be of interest to give the author's classification and comment on this specialized type of craft:

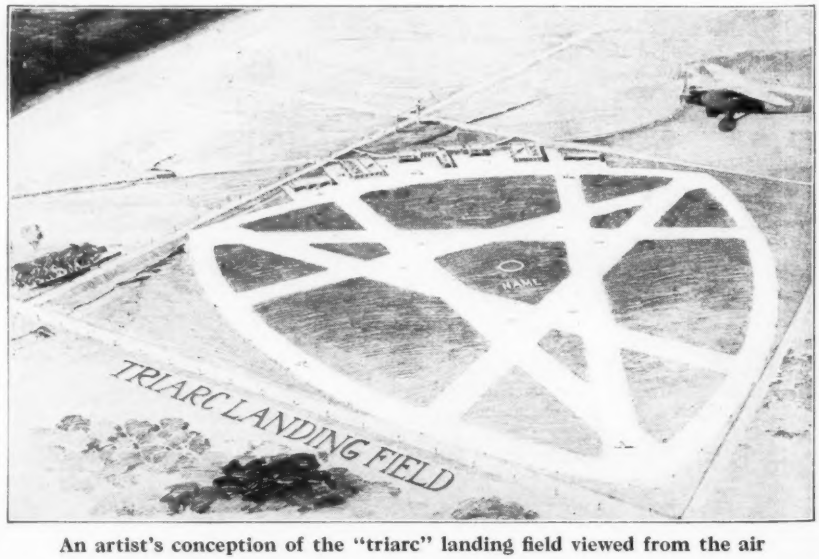
"Dinghies actually tested are of three types, which may be classified as inflatable, folding, and rigid.

"The inflatable type consists of an oval-shaped rubber raft, the periphery of which is of hollow rubber which can be blown up by a hand pump. The time taken to inflate may be ten minutes, but small cylinders containing carbon dioxide have been designed for use in emergency. Its disadvantage is that the rubber is too liable to damage for use in emergency. Its advantages are that it can be stowed into a small space and that as long as it remains unpunctured, it would support a crew of five or six.

"The folding type has many variations. It has been constructed with a light ash frame-work covered with canvas, and also combined with the inflatable type, and one of the most successful has consisted of thin wood with canvas hinges combined with a surround of floating material. This type has the advantage of being stowable inside a hull and can be assembled rapidly on the center section. But in emergencies it definitely relies on the amount of floating material in its construction for the buoyancy afforded to a crew.

"The rigid type has been built in both wood and metal, and provision has been made for attachment outside the hull. It relies on water-tight compartments for remaining afloat when flooded. It is the strongest of the dinghies used, rapidly available for use, but heavier than the other types."

It would seem on the whole that the small



An artist's conception of the "triarc" landing field viewed from the air

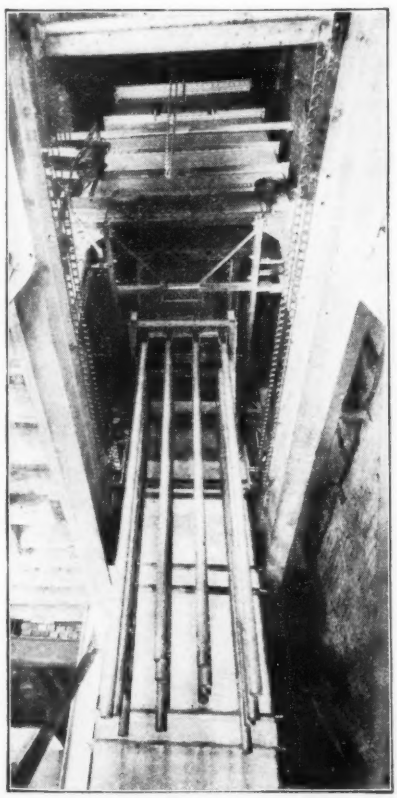
boat is an expensive luxury, and that it will only come into general use on very large flying boats.

Vertical Heat-Treating Furnace

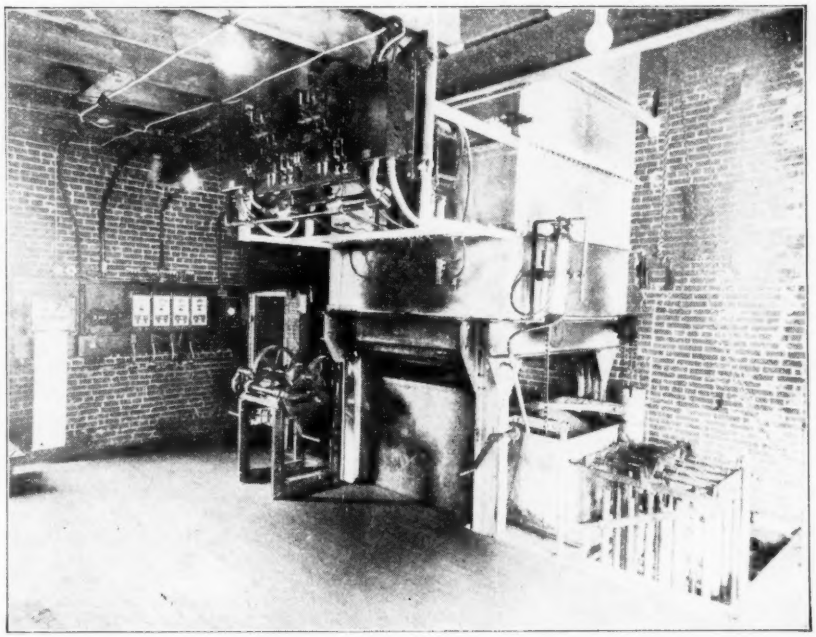
THE construction of airplanes is rapidly passing from wood to metal, either alloy steel or duralumin, and with both metals heat treatment is essential. In airplane construction, particularly as regards wing spars, much longer members are encountered than in automobile practice, and special heat-treatment furnaces have to be devised. With very long members the difficulty is two-fold; the member to be heat-treated must remain straight and the temperature at every point along its length must remain the same. Metallurgical Laboratories of Philadelphia have devised a new type of vertical furnace in which spars 10 feet long can be heat-treated, and a furnace under construction will be able to handle 25-foot lengths. The furnace is described in a recent issue of *Automotive Industries*.

The parts to be treated are suspended from a spider of chrome alloy by means of Nichrome hooks. Suspension takes care of keeping the tubes straight. To secure uniform temperature, the heating units are divided into four sections, mounted at different levels and each provided with its own automatic temperature control.

In one of our photographs, the four control units are shown mounted on the wall. These units operate control switches, mounted at the side of the furnace close to the ceiling, which cut the heating units in and out of the circuit as determined by the controller units. The other photograph shows some suspended members, as seen from below.



Heat-treating furnace from below, with suspended tubes in position



Temperature control system of the new furnace for treating airplane members. This is described in these columns, and another view appears below

The chamber of the furnace now operating is three square feet in cross-section and 10 feet long, and has a capacity of 400 pounds per hour. The quenching tank, together with a loading platform adjacent to it, is mounted on rollers and can be moved laterally with respect to the furnace by means of a hand crank. The furnace has a movable bottom which, being counterbalanced, can readily be lowered by hand, and can then be moved to one side so as to leave the opening of the furnace free for the introduction or removal of a charge. At the bottom of the quenching tank there is a drain or sump which has sufficient capacity to take the entire contents of the quenching tank. This is convenient when desiring to change from oil quenching to water quenching.

135 Passengers

ACCORDING to *London Airways*, Dr. Rumpler, the German constructor, is now building the largest flying boat yet attempted. It will be equipped with 10 engines and carry a crew of 35 with accommodations for 135 passengers in its wing. The flying boat will have two hulls, and the engines, fuel tanks, and passenger quarters will be distributed along the span of the wing. The theory of this distribution of the load is that bending moments on the wing will be diminished and its weight kept down in spite of the enormous dimensions of the craft.

An Aviation Ticket Office

AMERICAN aviation has often been reproached for lagging behind in passenger air-transport and for not bringing air travel within ready reach of the public. Both reproaches will soon cease to have any justification. Air Associates of New York City announce the establishment of a consolidated ticket office in their Fifth Avenue headquarters. This will enable a passenger to reserve a seat on any passenger-carrying line in the United States or Europe, or to arrange for chartering an aerial taxi. From New York City regular passenger services are, or soon will be, available which will take a passenger by air to Chicago, to the Pacific Coast, to Canada, and, in combination with rail service, to Havana.

Aviation Law

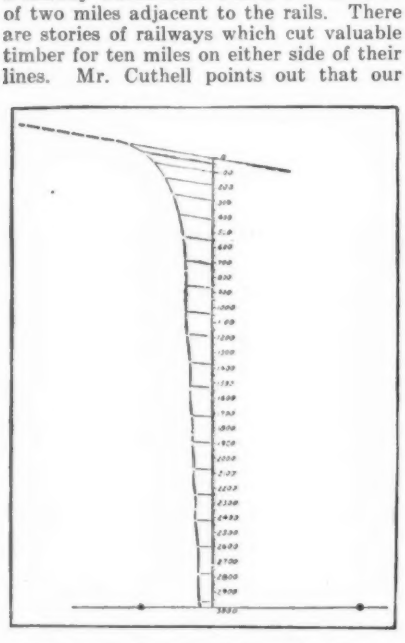
CHESTER W. CUTHELL, President of the American Bar Association, is a distinguished attorney whose major professional interests lie in aviation. His views on the legal problems of aviation are therefore authoritative. In his paper before the International Civil Aeronautics Conference in Washington, Mr. Cuthell brought out some interesting points.

There is an interesting axiom which states that the individual who owns the surface of the ground owns all of the air space to the sky and to the center of the earth. Such an idea would render trespass in flying inevitable and make commercial flying practically impossible. Fortunately there are some legal decisions already available which render this ancient maxim invalid. Thus, Judge C. Michael of the District Court of Minnesota has stated in a case: "The upper air is a natural heritage common to all of the people, and its reasonable use ought not to be hampered by an ancient artificial matter of law as is here invoked. To apply the rule as contended for, would render lawful air navigation impossible, because if the plaintiff may prevent flights over his land then every other landowner can do the same."

Mr. Cuthell urges that there should be uniformity between the Federal law in aviation and the laws and regulations of the various states. Flying makes even a huge country like the United States shrink to modest dimensions. It would be disastrous to have a variety of laws in states which by air are only a few hours apart.

Practice in Europe is almost invariably to adopt subsidies. In the United States, the word subsidy is abhorrent. Yet the railways in the early days received direct

aid in the form of land grants. Sometimes a railway would receive land over a width of two miles adjacent to the rails. There are stories of railways which cut valuable timber for ten miles on either side of their lines. Mr. Cuthell points out that our



Path of dummy dropped from speeding plane. See text at right and other explanatory drawing below

government has rightly avoided subsidies, because the distinguishing characteristic of the American has been his individual initiative and our government very properly is loath to destroy that initiative by the grant of sums of money to selected groups.

"Nevertheless," said Mr. Cuthell, "our government has rendered very substantial aid to the business by encouraging the carriage of mail by public contract held by private companies. It has also aided indirectly in the establishment of airways and the incidental emergency fields, lighting equipment and weather reporting service. It undertakes also the inspection and examination of planes and pilots. In extending these aids it is doing nothing more than it has done in establishing lighthouses, buoys, boiler inspection, and examination of pilots in connection with ship operations, and in the point of money expended, the assistance thus rendered is far less than the assistance rendered to the automobile manufacturers and bus operators in the form of the systems of the modern highways."

Other legal problems which yet remain to be solved, are the liability of the owner of aircraft to the passengers carried, and limiting the use of aircraft in its present stage of development to those individuals who have been thoroughly trained by competent teachers. While there is keen rivalry among aviation manufacturers and operators, there has been little litigation. Lawyers are therefore free to concentrate on action which has the general good of the country as its objective.

While writing this abstract of Mr. Cuthell's valuable paper, we have received a valuable text "Aircraft Law Made Plain," by George B. Logan, published by the Van Hoffman Press, St. Louis. Written especially for those interested in aviation, such as prospective craft owners, operators, investors, and students, it avoids all difficult legal verbiage and makes matters clear and simple for the layman. A few items from the table of contents will furnish a trustworthy guide to the material presented: "Where may I fly? Who may regulate me or my plane? What are my liabilities? What effect will riding in or operating an airplane have on my insurance? Where will cases be tried arising out of air crimes, air-made contracts, wills, marriages, etc?"

Studying Parachute Jumps

LIEUTENANT A. G. FOULK, writing in *U. S. Air Services*, reports some very interesting studies of parachute jumps made by members of the Army Air Corps. Many questions of vital importance to parachute designers have now been solved. How far and how rapidly will a man drop in a given number of seconds? What is his limiting velocity? If the opening of the parachute is long delayed will the man become unconscious? Will the shock of opening, when long delayed, burst the 'chute? What is the minimum height from which a parachute jump is safe?

A simple, yet ingenious method of study was adopted. The tests were conducted at night. The apparatus consisted of an ordinary view camera, a shutter timing device, and a dummy equipped with a magnesium flare. The camera shutter was so arranged that it remained open except when snapped shut momentarily at one second intervals by means of an electric solenoid. A pendulum making one swing per second and coming in contact with a bubble of mercury at the bottom of each swing, served as a timer.

The airplane flew at a known altitude, and followed as nearly as possible a course perpendicular to a vertical plane through the axis of the camera, which was horizontal. When the dummy fell with its blazing flare, its path was recorded on the film as a series of dashes, the length of the dashes being proportional to the distance covered by the dummy during the corresponding one-second intervals. The photograph obtained in this manner, with a suitable reference scale, gave the plot of distance traveled against time. From this the velocity of the dummy at any instant could be readily deduced. The dummy weighed 180 pounds, and was constructed with dummy parachute pack so as to simulate a man.

Starting at 3000 feet, from a plane traveling horizontally at 80 miles per hour, it took the dummy nearly 21 seconds to reach the ground.

The limiting velocity of the dummy was about 120 miles per hour. As soon as the dummy picked up speed, the air resistance increased until it became equal to the weight of a man. Beyond this point there could be no further acceleration.

The chances of a man becoming unconscious if the opening of the 'chute is long delayed are therefore negligible. While 120 miles per hour is a high speed, any aviator in an open cockpit can withstand a blast of 120 miles per hour without much discomfort.

For similar reasons, there is not much chance of the parachute bursting because of delay in opening. In fact, if a man jumped from a plane diving at 200 miles per hour, as might well be the case if the wings had come off, his speed in the air would actually diminish; he would lag behind the falling plane.

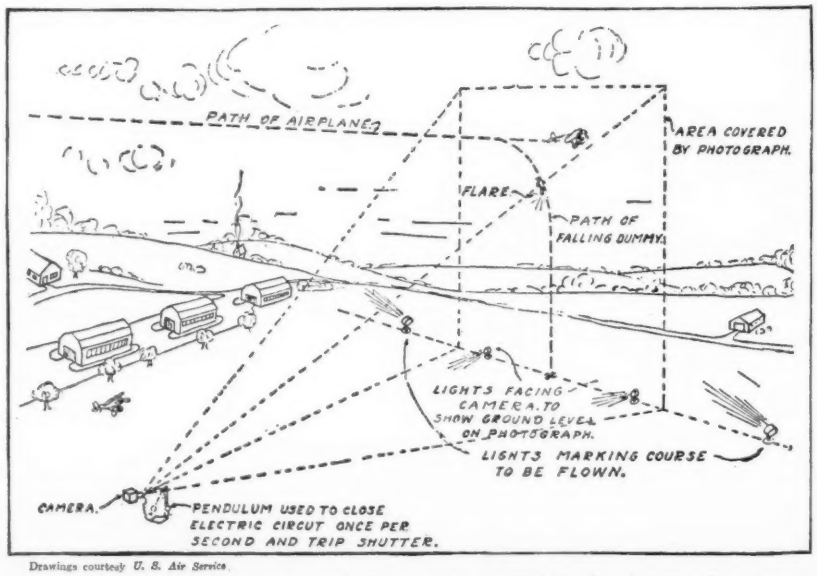
With plenty of altitude there is apparently no reason for a hurried pulling of the rip cord. The only reason for hurry is a psychoiogical one; jumping through space, one would like to make sure as soon as possible that the parachute is actually going to function.

The question of minimum height from which a parachute jump can be safely made was not answered definitely even by these experiments.

Starting from a plane having a horizontal velocity of 80 miles per hour, the dummy dropped 175 feet in three seconds. Since it takes a parachute three seconds to inflate, a height of 175 feet would have been the barest minimum for a safe jump under these conditions.

If the plane had been flying more rapidly in a horizontal direction, the inflation would be speedier and in such a case the jump would become safe at something under 175 feet.

With a plane flying slowly, near the stalling speed, the rapidity of inflation would be less, and the height required would be greater.



Drawings courtesy *U. S. Air Service*

Diagram of the apparatus used to investigate the fall of a dummy from an airplane. The results of these tests indicate the relative value of parachutes

In a plane diving towards the ground at the instant of the jump a far greater height would be necessary.

While not every question is yet answered regarding jumps, our knowledge is accumulating to the point where a pilot will know with reasonable accuracy what he may and what he may not do.

An Ice-Warning Indicator

THE formation of ice on the wings still remains one of the greatest hazards of flying. So far all methods of combating such ice formation have proved unsuccessful. The best plan is to provide the airman with such weather service as will enable him to avoid flying under conditions likely to lead to ice formation, and to instruct pilots carefully as to what to do when there are signs of ice such as glide down to lower and warmer altitudes, for example. The Boyce Motometer Company of Long Island City has developed an ice-warning indicator which may be useful. The indicator is similar in principle to the strut thermometers often used on Army planes. The bulb of the thermometer is filled completely with Zylene under pressure. Any application of heat or cold at the bulb causes the entire column of liquid to expand or contract. The bulb is connected by a fine capillary tube to a Bourdon spring, which coils or uncoils as the liquid contracts or expands. The movement of the Bourdon spring moves a pointer across a dial mounted in the pilot's cockpit. On the upper scale of the dial, there are graduations from 40 to 100 degrees, Fahrenheit. Mounted below the mechanism described is a secondary movement similar to that employed in the ordinary type of pressure gage. When the pointer on the upper scale comes down to 42, a pin engages this secondary movement and the pointer on the lower scale is brought into use, giving a clear indication over an enlarged scale in the cold danger zone.

Special thermometer designed to warn of impending ice formation

Future of the Air Mail

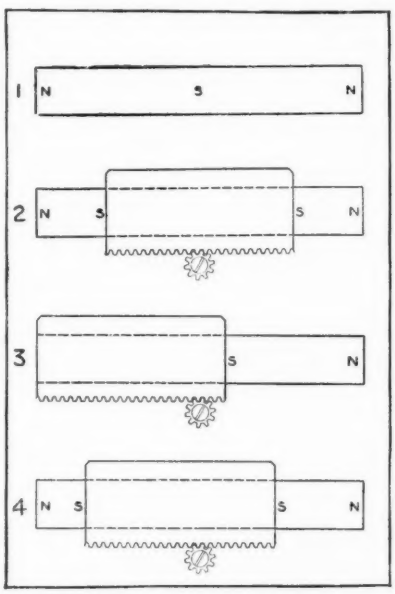
WILLIAM IRVING GLOVER, Assistant Postmaster General, writing in *Popular Aviation*, makes some startling yet well founded prophecies regarding the future of the air mail. Already 65,000,000 persons or more than half the population of the country are direct beneficiaries of the air-mail system. Within two years, Mr. Glover predicts, every city with a population of 50,000 will have direct access to an air-mail route. There will be large volumes of night mail transported by air.

The air post office clerk will sort these letters while flying through the air at 100 miles an hour or more. To accommodate the larger amount of mail carried, and to provide suitable working quarters for this new type of post office clerk, large and specially designed planes will be necessary. Airplane manufacturers and designers have already given much thought to the new designs that will be required. The railway companies will lose a certain amount of revenue, and the far-sighted railway companies may therefore seek alliances with the air transport companies. In fact they have already done so in three or four cases.

Planes of the future, Mr. Glover thinks, will carry 5000 pounds of postal matter. When the air mail started, the DH4 planes put in service had a maximum capacity of 500 pounds. With the five cent air-mail stamp in use, there are now being carried 300,000 letters daily. There is also an increasing business in packages, weighing one, two, or three pounds. Manufacturers of eye-glass lenses, film makers, manufacturers of small medical instruments, and wholesale chemists, are prominent among the patrons of this service.

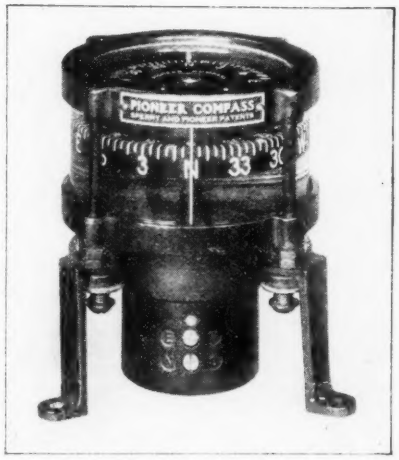
A Novel Compass Compensator

NO matter how well adjusted an airplane magnetic compass may be, it will read incorrectly when placed in the airplane. This is due to the presence of iron or steel employed in the construction of the airplane, which may be magnetized to such a degree as to change the compass readings from normal. Loose magnets have been employed hitherto to correct these discrepancies, some placed in line with the axis of the airplane, some athwartship. The loose magnets furnish a somewhat erratic means of compensation for magnetic disturbances, but the Titterington Micrometer Compensator produces an accurate method of correction.



This diagram shows how the compass compensator works. Numbers at the left are refered to in text

The compensator is based on an entirely novel principle. The basis of the compensator is a permanent magnet with north poles at each end and a south pole at the center as shown in the drawing. The effective external field of this magnet is zero, as it is the equivalent of two magnets which just balance each other. Around this special double magnet is a soft iron tube, half the length of the magnet, which acts as a magnetic shield. When placed in the middle of the magnet, 2, the tube shields one half of each end of the magnet, leaving the effective external field still at zero. By turning a screw, which is geared to the tube, the shielding tube can be moved to one end of the magnet or the other, 3. The tube can be thus made to shield either half of the double magnet, leaving the external field of the other half fully effective, the result being a N-S magnet of maximum strength. Stopping the tube at any intermediate point, shields each end partially and leaves an effective external field of reduced strength.



An airplane compass equipped with the new compensator described in these columns. Adjusting screws are on lower cylinder

The compensator as used on the typical magnetic compass contains two such center-pole magnets, one (the upper) being fore-and-aft, and the other (the lower) being athwartship.

To compensate a compass, the following simple method is followed. The direction is determined by means of a magnetic compass suspended from a wing tip. The ship is headed toward the magnetic north pole. If the ship's compass does not read N, the lower compensator screw is turned until the compass does read N. A special non-magnetic screw driver should be employed. Next the airplane is headed due west. If the compass does not read west, the upper compensator screw is turned until the compass does read W. Next the airplane is headed due south. If the compass does not read S, the lower compensator screw is turned to take out half the error. The same process is repeated heading the airplane due east. When errors have been eliminated in this fashion as ar as possible, the airplane is swung successively N, 330, 300; W, 240, 210; S, 150, 120; E, 60 and 30 degrees, and the compass indication is noted on each heading on a correction chart. One of the first duties of a pilot who is to undertake long cross-country flights is to learn how to compensate his compass in this fashion.

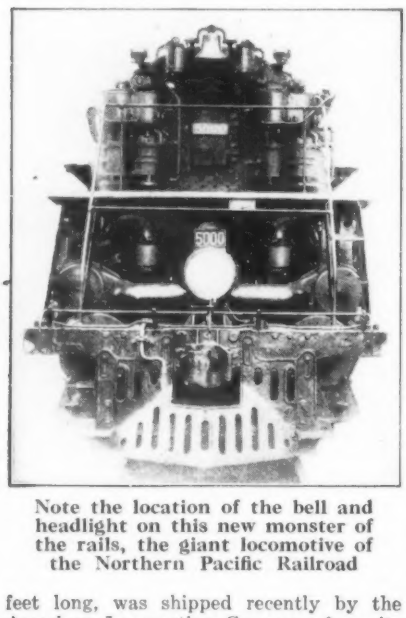
The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

World's Largest Steam Locomotive

THE largest steam locomotive in the world, which measures nearly half the length of an ordinary city block and three times the length of a standard freight car, has been constructed for the Northern Pacific Railway.

This leviathan of the rails, which is 125



Note the location of the bell and headlight on this new monster of the rails, the giant locomotive of the Northern Pacific Railroad

feet long, was shipped recently by the American Locomotive Company from its plant at Schenectady, New York, to H. H. Stevens, vice president in charge of operation on the Northern Pacific. It is experimental and is of the four-cylinder simple Mallet type.

The enormous proportions of this locomotive, which will ride the rails on 34 wheels, including 12 on the tender, were conceived by its designers and builders with a view to burning semi-bituminous coal, of comparatively low heating value, which is obtained from an open pit mine in the Rosebud coal field in southeastern Montana, operated by the Northern Pacific.

Other features of this super-locomotive are:

In working order, with coal and water, it weighs 1,116,000 pounds.

Its height from the top of the rail is 16 feet, four inches.

It has a normal tractive power of 140,000 pounds and a total tractive power of 153,400 pounds, including the trailer type booster, with which the engine is equipped.

The firebox, which is built to provide the greatest heating surface for burning the semi-bituminous coal, is equipped with five thermic syphons, three of which are in the firebox and two in the combustion chamber; the firebox, including the combustion chamber, is 28 feet, six inches long by nine feet, six inches wide; the grate is 19 feet, two inches long by nine feet, six inches wide, making a total of 182 square feet of grate area.

It has a mechanical stoker, which is of special design and is capable of crushing, delivering, and distributing to the firebox hourly a maximum of 45,000 pounds, or 22½ tons of coal.

Its tender has a capacity of 22,000 gallons of water and 27 tons of coal.

Water is supplied from the tender to the feed water heater and thence to the boiler by two centrifugal pumps. The engine is equipped with all of the most modern devices for efficient and safe operation, including automatic train stop.

This giant locomotive, according to operating officials of the railroad, will be placed in regular freight service between Glendive, Montana, and Mandan, North Dakota. The territory over which it will operate is of undulating profile, with controlling grades of 1 percent so separated over the territory that it is impracticable to establish helper or pusher districts. Up to now, over this section, it has been necessary to handle in two trains the tonnage which is carried in one train both west of Glendive and east of Mandan. This powerful new locomotive has capacity to pull between Glendive and Mandan in one train the same tonnage that is handled east and west of this 216-mile stretch where it will be in service.

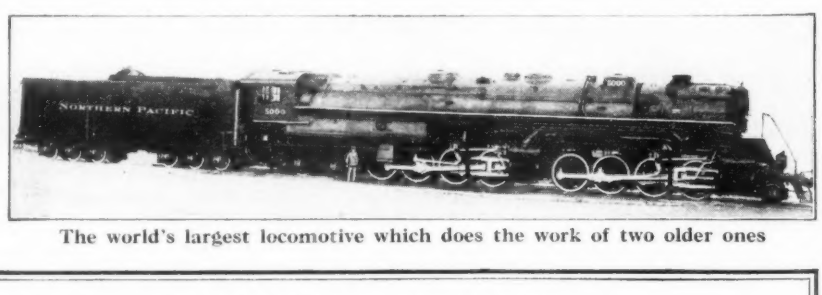
Britain Plants for New Forests

GREAT BRITAIN is planting new trees at the rate of 1,000,000 a week, according to information reaching the United States Department of Agriculture.

Before the war, the British government estimated that there were about 3,000,000,000 feet of standing timber in the British Isles, while today it is estimated that the timber resources have been reduced to half that amount.—*Science Service.*

Wilkins Returns From Antarctica

AT THE time this is being written, Captain Sir Hubert Wilkins is making preparations to leave his base on Deception Island in the antarctic where, for the past



The world's largest locomotive which does the work of two older ones

The Scientific American Sea Safety Gold Medal Committee of Judges

IN announcing, in January, the SCIENTIFIC AMERICAN Gold Medal for 1929 to be awarded for the device or apparatus most conducive to safety at sea, we stated that the American Museum of Safety, under whose supervision the medal will be, would select the Board of Judges at once and that we would announce the names of the men on this board in this issue. Since this board is not quite complete, we can list only those who have already agreed to serve. They are:

Rear Admiral C. McR. Winslow, U. S. N. (Ret.) Chairman
Rear Admiral Charles P. Plunkett, U. S. N. (Ret.)
Rear-Admiral W. S. Benson, U. S. N. (Ret.)
Captain Charles A. McAllister, American Bureau of Shipping
Captain Felix Riesenberg, Martin Motors, Inc.
Captain T. H. Lyon, International Mercantile Marine Company
Mr. H. H. Brown, Editor, *Marine Engineering and Shipping Age*
Captain Henry McConkey, Port Superintendent, Cunard Line
Captain E. T. Fitzgerald
Mr. Louis Weickum, Hamburg-American Line
Mr. A. B. Newell, Editorial Staff, *Motorship*

It is expected that the board will be complete within a few days, the first meeting held and the rules drawn up; and we shall, doubtless, be able to give all details pertaining to the competition in our April issue. In the meantime, we are happy to say, many letters approving our encouragement of sea safety are being received by us and by the American Museum of Safety each day. Already several entries have been made in the competition and others are expected immediately.

few months, he has been making explorations by airplane over hitherto unknown land. He has just completed the first phase of his explorations and has announced by radio his intention of returning to America to prepare for the second phase which will be carried on next year from a different base.

Prior to making this announcement, Wilkins had made a flight over Graham Land seeking a suitable base from which he could continue his explorations farther south, but was unsuccessful.

The *New York American* analyses the situation as follows:

"The Wilkins-Hearst Antarctic Expedition had two major objectives: First, exploration of Graham Land and the western coast of Weddell Sea by airplane; and second, a flight from Graham Land to Ross Sea and further exploration from a base established there.

"In flights from Deception Island over Graham Land, Captain Wilkins and his associates have accomplished the first objective and thereby solved the greatest problem that has confronted scientists and geographers in the antarctic.

"Graham Land is pictured on the maps as part of the Antarctic continent. Flying 1200 miles over land never before seen by human eyes in company with Pilot Ben Eielson on December 20, Wilkins discovered that Graham Land consists of two main islands and that the southernmost is separated from the Antarctic continent by a body of water 40 to 50 miles wide, lying between the 70th and 71st parallels south and longitude 60 and 70 west. This he has since named Stefansson Strait.

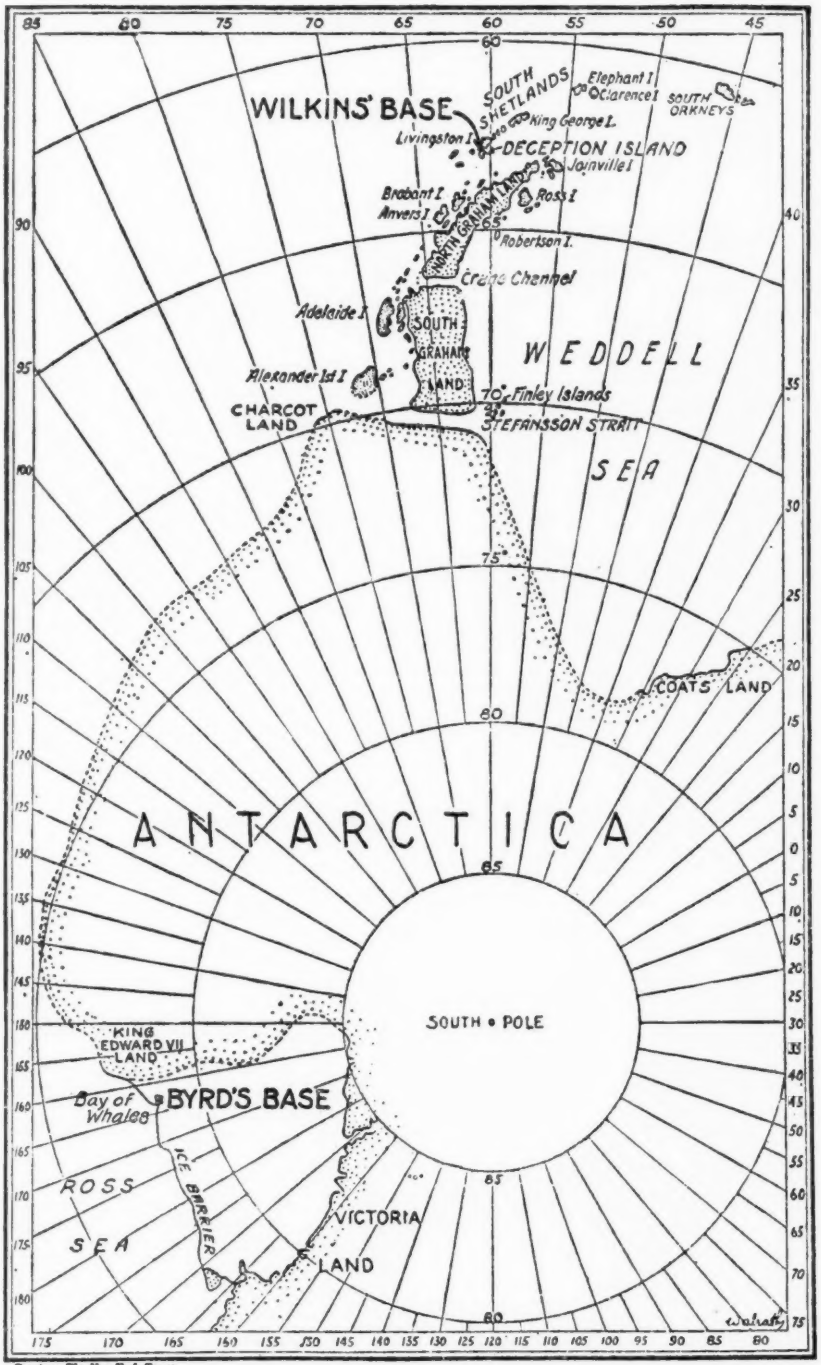
"The northern island has been renamed North Graham Island, and the southern, South Graham Island, the two being separated by a narrow, crooked strait.

"On the 65th parallel south, or within 100 miles of the Anarctic Circle, Wilkins found the coast of North Graham Island cut by indentations so deep that they almost met, threatening to sever it into still another island. These indentations he named the Hektoria Fiords.

"A group of six islands discovered southeast of South Graham Island he has named Finley Islands, in honor of Dr. J. H. Finley, president of the American Geographical Society, which sponsored the expedition.

"Captain Wilkins established what he believes to be the true edge of the Antarctic continent on approximately the 70th parallel south. This he has named Hearst Land, in honor of William Randolph Hearst, by whom the expedition was largely financed.

"One portion of the South Graham Island coast, Captain Wilkins designated as Bowman Coast, in honor of Dr. Isaiah Bowman, director of the American Geographical Society. Various mountains, plateaus, glaciers, and other geographical features were named for different persons whom Wilkins desired to honor."



Courtesy The New York Times

Map showing Wilkins' base on the Antarctic Continent. Graham Land, formerly thought to be part of the continent, was found to be two islands

Dogs Given Immunity to Distemper

A MEANS of protecting dogs against distemper, the canine "flu," has been found, although their human masters have still no sure means of protecting themselves against influenza, the disease which recently caused considerable alarm in the United States. The method of immunizing dogs against distemper has just been made public in a report by the Distemper Research Committee to the Medical Research Council and the Distemper Council of *Field*, a London magazine. The method, which is an inoculation, has been developed by Dr. P. P. Laidlaw and G. W. Dunkin. Inoculation and vaccination have been tried as a means of preventing influenza among humans, but so far have been unsuccessful.

The method consists of a double inoculation. The first inoculation is made with a vaccine which is, in fact, the inactivated virus of distemper. The second is made, after an interval of about 10 days, with an attenuated strain of living virus. The dose of living virus is a hundredfold that which would infect a dog not previously treated with the vaccine, but as a rule it is followed by nothing more than a trivial and transient disturbance of health; often no departure from the normal can be detected. Dogs which have undergone this inoculation have proved to be completely resistant to the disease thereafter, whether exposed to infection by being placed in close contact with animals suffering from the disease or by the administration of infective material.

The preparation and administration of the vaccine require especial skill, but arrangements are under way for large scale production so that the protective material will soon be available generally. Sufficient time has not yet elapsed to judge of how

long the protection will last, but it is thought unlikely that it will decrease.

Distemper, of course, is not exactly the same as the human disease of influenza, but it is an acute bronchial or respiratory disease of dogs. The importance of the present work is not limited to the canine field. The complete solution of the problem demands the cultivation of the virus apart from the living animal. Any advance in the knowledge of one virus will probably advance greatly our knowledge in the entire field of virus cultivation and study. Since so many human diseases, including influenza, depend on greater knowledge of viruses, there is hope that the work of the Distemper Research Committee will contribute greatly to the prevention of human diseases.—*Science Service.*

Trapshooting at night by the light from searchlights promises to become popular, judging by results achieved

A view behind the traps at the recent experimental trapshooting meet held at night. Note searchlights

Trap-Shooting at Midnight

UNDER midnight skies and 2,000,000 candlepower in electric floodlights, three veteran trap-shooters, the oldest of whom was 81, recently broke from 19 to 23 clay pigeons out of a possible 25. This happened at the first night-time trap-shoot ever held, while a gallery of 400 spectators watched shattered clay pigeons fall at the range of the Lynn Fish and Game Association, at Lynn, Massachusetts.

Attracted by the novelty of shooting at clay pigeons as an evening recreation, nearly 60 trap-shooters from all over New England took part in the four events of the program. The dean of them was Norris G. Rowell, of Lynn, who is 81; his two fellow-veterans were Dr. F. L. Judkins, of Lynn, former New England champion, 75, and F. A. Farrington, of Peabody, Massachusetts, 73.

They experienced new thrills as they stood on the shooting platform and looked out toward the trap-houses, from which the clay pigeons were sent into the air 50 or 60 feet from the shooters, flying in the glare of 20 powerful floodlight projectors mounted on platforms 20 feet high.

"Yes, the idea is a good one," said Mr. Farrington, after the shoot was over. "It gives a man as good a chance to break the targets as it does in the day-time. It also gives a chance to the man who cannot devote time to the sport during the day. It will get more men interested in the game. I think it is going to be the popular way. Good scores can be made, and I think it is a big thing."

His prediction seemed justified as trap-shooters flocked to the range night after night to try it out, until a few nights later William Hill, professional gunner at Bridgeport, Connecticut, made a perfect score under the flood-lights—25 birds out of 25.

Lighting engineers of the General Electric Company, particularly F. W. Ralston, street-lighting engineer, laid out the lighting scheme. There were various problems to be overcome, such as making the pigeons sufficiently visible, the location of the flood-lighting units to avoid interference with the shooting, the lighting of the gunners and their guns, and special lighting facilities to assist the gunners in sighting.

Electric Machinery Cooled by Hydrogen Gas

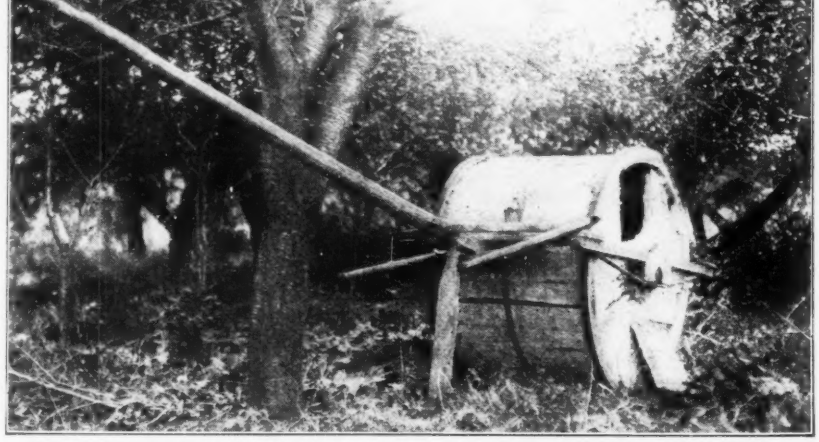
AS much as 50 percent more power can be handled by the same size electrical apparatus if it is equipped with a new system of cooling developed by the General Electric Company, it was announced by that company recently. The use of hydrogen gas within a totally enclosed rotating machine has made this increase possible without increasing the operating temperature beyond the point of safety, the company reports, and it is the temperature which has heretofore limited the load which can be carried.

The first commercial application of the new system of hydrogen cooling has been made on a synchronous condenser installed by the New England Power Company at its Pawtucket, Rhode Island, substation, which has a capacity of 12,500 kilovolt-amperes, as compared with only 10,000 kilovolt-amperes if an air-cooling system were not used. With hydrogen at 15 pounds gage pressure, the machine would deliver 15,000 kilovolt-amperes without exceeding the normal temperature guarantees, according to General Electric engineers.

Another advantage of the new system, it is said, is to exclude oxygen and dirt. Hydrogen will not support combustion, and fires of any kind, even from short-circuits, are consequently impossible, it is further declared. Hydrogen also eliminates the effect of corona on the insulation, the report says. The usual air-cooled machine must be placed within a building, but the hydrogen-cooled equipment can be placed outdoors, which is the case at Pawtucket, thus saving building costs. The totally enclosed apparatus is also said to be exceptionally quiet in operation.

Niagara Will Be Saved

EARLY in January and shortly after publication in our January issue of the article "Niagara Should Be Saved,"



Ingenuity is not confined to industry by any means. This practical concrete mixer, described in these columns, was constructed by a mid-western farmer

William Mackenzie King, Prime Minister of Canada, and William Phillips, the American Minister, signed, in Washington, D. C., an accord authorizing the construction of the remedial works recommended by the International Niagara Board and outlined in our article. The work is to consist primarily of submerged weirs and excavations in the rapids above the Falls, intended to preserve the scenic beauty of the Falls and to permit diversion of more water for power generation purposes.

A protocol describing the details of the proposed works was signed at the time the agreement was reached and will now have to be ratified by Congress.

The work, which is to cost around 2,000,000 dollars, will be carried out under the supervision of the United States and Canada by the Niagara Falls Power Company and the Hydro-electric Power Commission of Ontario.

Ingenious Home-Made Concrete Mixer

MUCH has been said and written regarding the native ingenuity of the average American and many contrivances in proof of it are constantly coming to light. One that has just come to our attention is a home-made concrete mixer of great capacity which was constructed by a farmer living near Kansasville, Wisconsin, and used by him to prepare concrete for use in improving his farm. The mixer is a two horsepower affair: two horses supply the power to operate it.

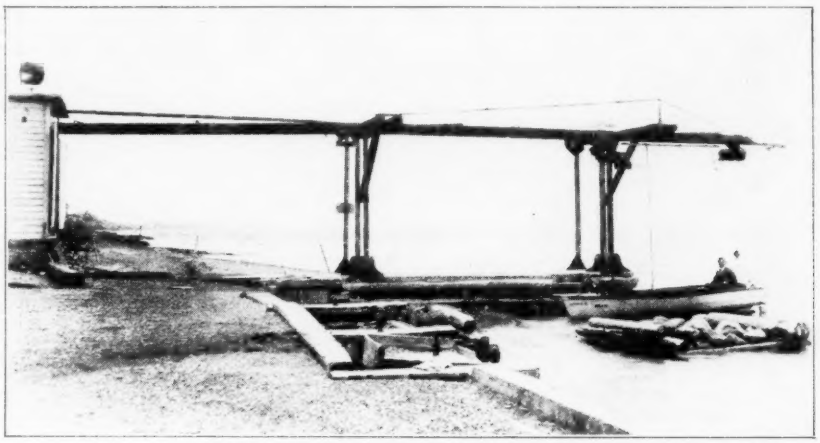
This "horse-power" concrete mixer is a large, barrel-like container with an axle through its center and with steel blades bolted to the inside. Cement, sand, stone, and water, in the proper proportions, are placed in the mixer through an opening in the side, a cover is placed over this doorway, and a team of horses is hitched to the tongue. After they have pulled the mixer for a few hundred feet, the concrete is ready for use.

Compressed Air Aids Shade Trees

COMPRESSED air forced in among the roots of large trees that have been transplanted has been found to be of assistance in causing the tree to recover quickly from the disturbance, as in most planting operations the dirt is thrown back into the soil with so much water that it puddles and prevents the roots from getting necessary air from the soil.

The same compressed air treatment is stimulating to trees in lawns where, apparently, the roots of the densely matted grasses forming the sod sometimes release so much carbon dioxide in respiration that the supply of oxygen in the soil is dangerously reduced. The method can also be applied to street trees which suffer greatly from leaking gas mains and from soil compactness due to paving, or to park trees where the soil is badly trampled by crowds.

The air is supplied by any air pump such as those used to fill air tanks at service stations or for pneumatic drills and hammers, and is forced into the soil through a deep nozzle. Many dying shade and ornamental trees can be encouraged to take a new lease upon life by a treatment of compressed air.—*Science Service.*



A new electric boat hoist. Two electric motors do all the work of launching or removing a boat from the water. One motor lifts the boat and the other carries it along the overhead track. Each is operated by a control rope. Trolley wires carrying the necessary current are strung along the track

Efficient Freight Bracing System

A PROBLEM of great importance with many manufacturers of today is the proper stowing and bracing of carload freight shipments.

While railroad equipment has been redesigned and strengthened to carry greatly increased traffic at higher speeds to meet the demands of present day business, until recently little thought was given to improvement of bracing for securing various types of ladings in the freight cars. Various forms of wooden blocking had been worked out. These methods were slow, costly, and did not insure safety for the cargo to any certain degree. Wooden bracing is applied to the walls and floors of the freight car and causes the cargo to become, in effect, a part of the car itself. It is apparent that this condition offers a resistance to the shocks rather than a means of absorbing them. Staggering damage claims, amounting to as much as 38,000,000 dollars annually, made it imperative that more efficient ways and means of bracing freight would have to be devised.

About three years ago, a new scheme of bracing was first tried out. This method, known as Unit-Load, employs heavy steel bands to draw the individual packages comprising the load into compact units, binding them tightly together so that, in effect, single units of great mass are created. Under very heavy impacts the units are free to shift slightly in the car. The steel bands about these units are not attached to the car walls or floor but are

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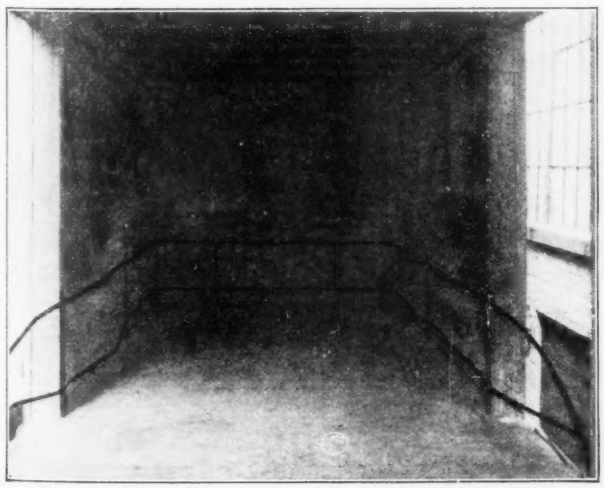


The steel strips used in the freight bracing system are spaced by vertical strips, which are tacked to wall

When the freight is in place, the workman clamps the steel strips together. This pulls strips from the wall

Industries From Atoms

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

Spontaneous Heating of Coal

THE Bureau of Mines' Technical Paper 409, on "Spontaneous Heating of Coal," by J. D. Davis and D. A. Reynolds, presents a critical review of the work of the bureau on this subject, correlated with the results of other investigators. The results of chemical and physical research, particularly those of most recent date, are assembled in abstract form and critically examined. Some of the general conclusions reached in this study follow:

1. All coals but anthracites undergo spontaneous heating; the liability of self-heating is greatest among coals of lowest rank.

2. Oxidation of the coal substance itself is the main cause of spontaneous combustion.

3. The process of spontaneous heating may be considered to take place in two stages. The first stage is operative at room temperature as soon as freshly broken coal is exposed to the air. It begins with the physical absorption of oxygen and is continued by the formation of a solid chemical compound of coal and oxygen, which is gradually decomposed as the temperature rises. This first stage of the process generates heat, but not as much as the second stage. The second stage involves the breaking up of the solid compound of coal with oxygen and the formation of the final oxidation products—carbon dioxide, carbon monoxide, and water.

4. Pyrite when finely divided can increase the tendency of a coal to heat spontaneously.

5. Opinions differ as to what effect moisture in coal has on spontaneous heating. Probably the effect of moisture is determined by the conditions of storage. If one could be sure of wetting only those parts of the storage pile where spontaneous heating would otherwise develop, he could very probably prevent it; the heat required to vaporize the water would be more than the oxidizing coal could supply. However, wetting down the surface of the whole pile changes the conditions of ventilation and may favor heating at points not reached by the water, where dangerous heating would not otherwise occur.

6. Chemical factors other than those touched upon in paragraphs 1 to 5 above have little or no influence on the spontaneous heating of coal.

Electronic Bombardment Said to Synthesize Rubber

SYNTHETIC rubber enthusiasts may get fresh encouragement from the announcement that in Germany, H. Plauson, noted physicist, has discovered a mode of producing chemical rays through a modification of the Coolidge and Leonard tubes that can polymerize isoprene, butadiene, and their homologs and analogs to caoutchouc with great rapidity, and that can even convert rubber solutions into an insoluble state without the use of sulfur.

From the purely scientific standpoint the report is perfectly acceptable, but it should be taken with the realization that the path from the physical laboratory to the rubber tire factory is long and torturous and beset with many dangers.

Chemists Compress Years Into Days

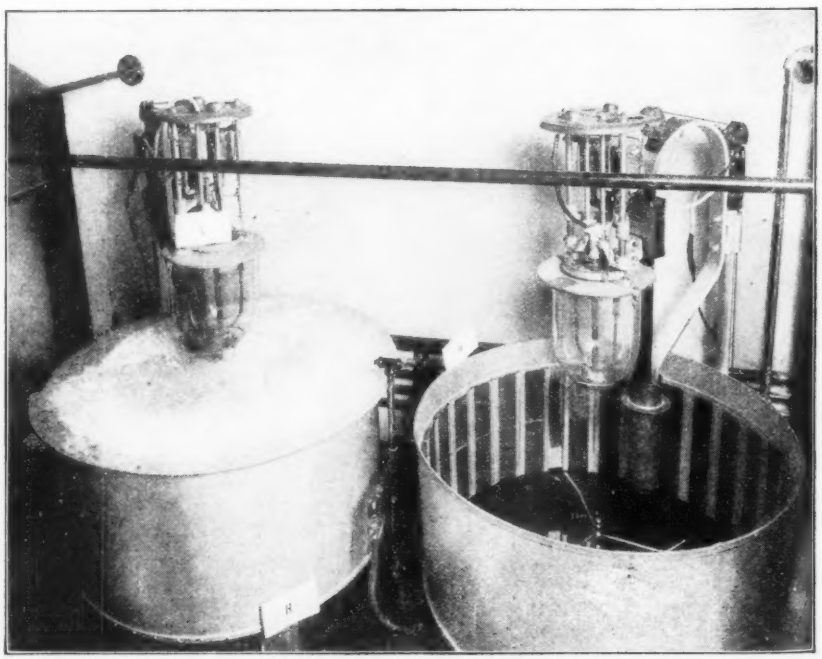
"BACKWARD, turn backward, Oh Time in thy flight—" sings the poet, but the chemist more often has reason for reversing the sentiment—"Hurry on Time, so that we can see how this new material is going to stand up." In the field of protective coatings this desire is especially urgent, and the chemists' attempt to peer into the immediate future has resulted in the development of numerous ingenious "accelerated weathering tests" calculated to reveal, in a comparatively short time, the effect of long exposure to the elements. Light, moisture, temperature changes, and normal air are the important causes of decay of paint, varnish, and other organic protective coatings. In general, the most important of these is light.

The United States Bureau of Standards has devised the exposure chamber illustrated here for testing small panels painted with the material under investigation. The chamber for exposure to light and moisture consists of a rotating cylinder made of 16 gage galvanized iron, 30 inches in diameter, 15 inches high, open at both ends, with the light suspended in the center. This size was selected so as to bring the light as near the panels as possible, at the same time avoiding too high temperatures. The cylinder has a capacity of 60 three by six inch panels.

The test panels are placed in two tiers immediately opposite the light inside the cylinder, the panels thus being 15 inches from the center of the light source. This gives a temperature of about 52 to 55 degrees, Centrigrade, at the panels with the type of lamp used. Thirty slotted holders, three inches wide and about 13 inches long for panels three inches wide, are attached to the inner surface of the open cylinder. The exposure cylinder is provided with water sprays, so that it is possible to expose the panels in succession to intense light and to a variety of moisture conditions. A pan placed in the bottom of the cylinder contains water and serves to keep the temperature down to about 52 degrees, Centigrade, next to the panels, as well as to humidify the air. Separate cabinets for exposure to gases and refrigeration are provided.

In addition to light exposure, the panels are subjected from time to time to several hours of vigorous spraying with warm (100 degrees, Fahrenheit) water. The panels can be removed to a special chamber for this purpose, but it is more convenient to produce this artificial rain in the chamber used for the light exposure. For this purpose the light is raised out of the cylinder, a common rotating lawn sprinkler is put in, and the top of the cylinder holding the samples is covered by a galvanized iron lid.

The illustration shows the arrangement for spraying the panels with water. The right-hand unit with the cover removed



To determine the comparative qualities of paint samples, the Bureau of Standards has designed this exposure chamber. It rotates slowly, exposing painted panels to the weathering action of a sprinkler or a brilliant arc light

shows the rotating spray, the slots containing test panels, and the protecting tube over the lower part of the lamp support. The left-hand unit shows the lid in place.

In order to simulate a hot, humid climate, a fixed water spray has been mounted in the tank in such a manner that it may function when the lights are operating.—*From an article published in* Bureau of Standards Journal of Research *for July, 1928 (Vol. 1, No. 1) under title of "Accelerated Tests of Organic Protective Coatings," by Percy H. Walker and E. F. Hickson.*

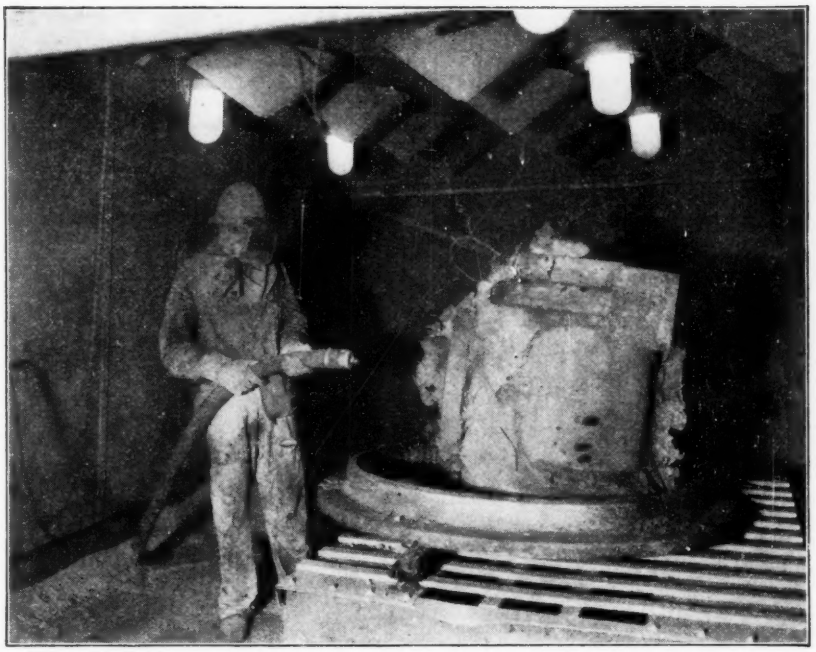
Bakelite and Asbestos Combined in New Acid-Proof Material

AMONG the new materials of construction for corrosion-proof equipment is a unique synthetic product known as Haveg. It is said to be unaffected by non-oxidising inorganic and organic acids and other reagents. It stands a temperature of about 130 degrees, Centigrade. In spite of its lightness (its specific gravity is 1.6) it withstands a pressure of about 5.2 tons per square inch and a bending strain of about 2.8 tons. It is composed of Bakelite, the well-known artificial resin, mixed with asbestos fibers. From the list given of acids by which it is unaffected, it appears to have considerable possibilities wherever acid or neutral baths, or solutions made alkaline with soda ash are employed. It is not suitable for caustic soda solutions.

Vacuum Distillation Produced Pure Manganese

PURE manganese has recently been produced in the Bureau of Metallurgical Research of the Carnegie Institute of Technology. Samples of the metal, which never before has been produced in quantity in such a purified state, and of the furnace in which it was made, were exhibited at the open meeting of the Metallurgical Advisory Board held in Pittsburgh recently.

Pure manganese has a bright silvery luster, and unlike many pure metals which are soft and ductile, it is extremely brittle and hard enough to scratch glass. The pure metal was distilled from crude metallic manganese placed in a pure magnesia crucible over which a similar crucible was inverted to condense the manganese vapor. The whole was placed in a closed silica tube connected with a high vacuum pump and heated by high-frequency induction using an alternating current of several amperes at a frequency of 20 kilocycles.



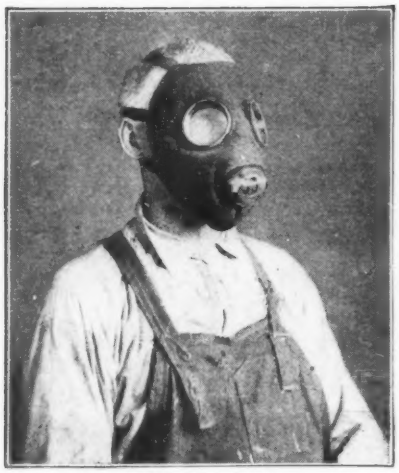
A sand blast operator in a special compartment, about to begin work on a large casting. Protected from the dust-filled atmosphere within the chamber by a special helmet, the operator receives fresh air by means of a small hose

Predict Cement As By-Product of Fertilizer Manufacture

CEMENT and fertilizer are products of two great industries built upon principles of chemistry, but there is no apparent relationship between the two manufacturing processes as conducted in the United States except this mutual kinship to chemistry. Reports from abroad however, indicate that the extension of chemical technique may result in the production of cement as a "by-product" of fertilizer manufacture.

According to *Chemiker-Zeitung*, the erection of factories in France for the production of ammonium sulfate and cement by the Leverkusen process has been held up, as it is thought possible to convert gypsum into ammonium sulfate as in the method of the Badische company, together with the simultaneous production of cement. M. Baud, the discoverer of the new method, carries out the reaction between gypsum and ammonia under a pressure of about one atmosphere in the presence of carbon dioxide and loam, which, by reaction with calcium carbonate, gives a sludge. This, after complete washing out of the ammonium sulfate, is heated to 1500 degrees, Centigrade, whereby cement clinker of normal composition is formed. The solution contains 27 to 28 percent of ammonium sulfate. The German account states that a con-

Two views of the office of the late Dr. Edgar Fahs Smith, noted educator and former President of the American Chemical Society. His collection of chemical memorabilia, one of the most valuable of its kind, has been presented to the University of Pennsylvania by Dr. Smith's widow, and will remain in its present setting



An English "full mask" dust respirator with loose felt filter, check valve for exhalation, and goggles

flict is at present in progress between the producers of ammonium sulfate (who regard this as the best nitrogenous fertilizer) and the producers of calcium nitrate, who oxidize synthetic ammonia by the Bamag or Parsons method.

Weed Killer Developed to Utilize Surplus Chlorine

AN Australian fertilizer producer, who also makes caustic soda by the electrolytic process, has found a use for the surplus chlorine that is generated in the process of electrolysing the salt solution. It is proposed to manufacture calcium chlorate, which has been found to exert a marked destructive effect on weeds. Experiments carried out under the direction of the Victorian Railways Commissioners, states the *Fertilizers and Feeding Stuffs Journal*, showed a 100 percent kill on weed-infested areas. In addition to being relatively cheaper than sodium arsenite, this material is non-poisonous, non-corrosive, and non-irritant to the hands of the operators. It is to be marketed under the name of "Weedex."

Motor Fuel From Sawdust is Indian Project

FAVORABLE results are being obtained in India on the experimental production of alcohol from sawdust of the gangwa tree, a fast-growing species, according to the Department of Commerce. Alcohol is regarded as the logical basis of motor fuel in India.

The glucose obtained is fermented to alcohol, and it has been roughly calculated that waste sawdust from Calcutta mills alone would yield 375,000 gallons of power alcohol yearly, on the basis of experiments using sulfuric acid. The use of fuming hydrochloric acid would give 40 percent greater yields, which would then amount to one sixth the production in India from all sources. Only 3,000,000 gallons are being produced locally at present.

In the experimental work which is being conducted at the University of Calcutta, yields of 30 to 33 percent reducing sugar (glucose) have been obtained from sawmill waste by treatment with sulfuric acid; 70 percent of this sugar material was fermentable, giving 33 to 39 gallons of 90 percent alcohol per ton of air-dried sawdust. The use of fuming hydrochloric acid in the initial hydrolysis gave higher yields of reducing sugar and 48 to 57 gallons of alcohol per ton of sawdust. Special acid-resisting vessels, such as are being manufactured now from synthetic plastics, would be required if hydrochloric acid is used.

Demobilized Gas Masks Find Jobs in Industry

IN its investigations relating to the safety and health of workers in the mineral industries the United States Bureau of Mines has given attention to the danger from breathing dusts, the means by which the workers might be protected, and the merits of dust respirators.

Poisonous dusts, such as those bearing lead or arsenic; some rock dusts, such as silica; metallic dusts, including those produced in grinding and polishing shops; and

This newly developed respirator of the Bureau of Mines gives more filtering space and aids respiration

many other dusts, including some organic dusts such as those in textile mills, are injurious when constantly breathed. Hard-rock miners, stonecutters, glassworkers, potters, and metal grinders are particularly exposed to this hazard. Everyone occasionally encounters a dusty atmosphere and experiences discomfort from it.

Gas masks and respirators are also demanded by conditions in certain paint-spraying operations. Operators of spray-guns are usually within arm's length of the gun being manipulated and may breathe some spray that fails to lodge upon the surface; also they may breathe vapors of paint solvents and thinners. When using paints that contain lead or other poisonous pigments it is best that the operator of the spray-gun be protected from inhaling the mist. Some paint solvents such as benzol, which has sometimes been used, or thinners, may evolve vapors detrimental to health.

Public Health Bulletin Number 177 states as a result of the tests that, in general, the respirators with cotton, paper, or fabric filters remove 90 percent or more of the lead from air carrying paint mist. These respirators restrain none of the solvent vapors. The addition of a canister or cartridge of activated charcoal to the respirator removes all solvent vapors until the charcoal becomes saturated. The useful life of filters is determined by their increase in resistance, which necessitates changing for fresh filters at intervals of several hours. When charcoal is saturated the cartridge must be exchanged for a fresh one. Canisters of the size used with gas masks may last for weeks before a change is necessary.

The respirators were somewhat less efficient against the silica-dust sprays, but they restrained 24 percent or more of the dust from the air passed through them; most were more than 50 percent efficient.

Emulsification of Asphalt Produces New Paint

AN entirely new paint material for the protection of surfaces exposed to severe conditions of corrosion has been made available by recent development of asphalt emulsions in water. The valuable properties of asphalt have long been recognized but heretofore this material has been applied either in a molten condition or in solution in volatile solvents. Neither of these methods of application are entirely satisfactory from the standpoints of effectiveness, convenience, or economy.

The progress of manufacture of asphalt emulsions involves the breaking up of the substance into extremely minute particles averaging from 1/5000 to 1/10,000 of an inch in diameter in the presence of water and a very small percentage of an inert mineral colloid. This is accomplished by flowing pure asphalt into an especially designed speed emulsifying machine in which propellers disperse the stream of asphalt into minute particles and at the same time combine it with water and the colloid. In this way the particles of asphalt are suspended and held in suspension until after the emulsion has been applied.

The importance which the paint industry attaches to this new development is indicated by the recent announcement that the duPont Company has joined forces with the Flintkote Company of Boston to

(*Please turn to page* 274)

For protection from dust only, the charcoal canister is omitted from this Fogler flat felt filter and mask

For hand made samples or production by thousands this *grainless* wood board

A business crisis. New models to build. Samples wanted yesterday and production costs skyrocketing. In just such emergencies industrial executives have turned to Masonite Presdwood, the easily worked, grainless wood board. In your business, too, it may be found profitable. May we send you samples with which to experiment?

FOR KITCHEN CABINETS

In the changing times that demand new methods, for the new competition that requires new products, there is an ever growing industrial need for Masonite Presdwood—with the strength, the lightness, the extreme workability that only this grainless wood board can give.

Skilled mechanics in the tool room, foremen in charge of big punch presses, find nothing in Presdwood to dull keen tools or wear out dies before their time.

For Presdwood is just clean wood that is blown apart and then pressed together, under tons and tons of pressure.

Because Presdwood does not warp, crack, split or buckle, there are no costly rejections in final inspection. And because it comes in ⅛th and 3/16th inch thicknesses and in standard 4 foot by 12 foot boards, there is almost no waste to boost production costs.

Resists Moisture — Takes any Finish

These grainless boards are smooth as glass on one side and textured like canvas on the other. The smooth hard surface with its delicate brown shading is naturally beautiful. The material resists moisture and requires no paint for protection. It can either be left in its natural state or finished to represent the finest type of natural wood.

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Presdwood is used in both building and industry. It panels apartments. It lines closets and elevator shafts. It makes smooth, light shelving and attractive partitions. It is the all 'round material for the inventor, the handy man, the home owner, as well as a product that is revolutionizing manufacturing methods.

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It is used for kitchen cabinets, starch trays in candy factories, doll houses and toys, hydroplanes and outdoor signs, table and work bench tops and the sides of panel bodies on motor trucks. And wherever used, it fills a need that is exactly met by no other material.

It pays to keep up with new methods and products. And it pays to know just what Presdwood can do in any manufacturing situation and for any specific purpose.

Samples to use in experimental work will be sent promptly on request.

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Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION
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FOR OUT DOOR SIGNS

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Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Aviation

FOURTEENTH ANNUAL REPORT OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS (1928) is the official governmental survey of the present status of the aviation industry. It reports the activities and progress of the committee, with a comprehensive review of the fundamental problems of flight and the technical advances made during the first 25 years of aviation history. *United States Government Printing Office, Washington, D. C.—20 cents.*

THE AVIATION INDUSTRY is a well executed review of the development of aviation in the United States with particular reference to the commercial aspects of the industry. It includes statistics of air mail and other flying operations, and reviews the scope and activities of the more important operators and manufacturers of aircraft, engines, and accessories. *Pynchon and Company, 111 Broadway, New York City.—Gratis.*

SURVEY OF THE AERONAUTICAL INDUSTRY IN THE NEW YORK METROPOLITAN DISTRICT analyzes the commercial aspects of the industry in the region covered, with a survey of the airplane transportation service available at the 17 flying fields of the metropolitan area. *The Merchants Association, 233 Broadway, New York City.—Gratis.*

Agriculture

AGRICULTURAL CORPORATIONS and SOCIALIZING THE SOULLESS CORPORATION, by Robert S. Brookings, are reprints of two papers that have appeared recently in the daily press. Mr. Brookings is a profound admirer of the methods of Henry Ford, and utilizes the well-known activities of the Campbell Farming Corporation in Montana as a model of agricultural engineering of the sort that will solve the ills of the farmer. The second paper is intended to bring out the fact that corporation methods will function in a chain of small farms as successfully as such methods have proved in chain store merchandising. *The Brookings Institution, Washington, D. C.—Gratis.*

MILK—FROM FARM TO REFRIGERATOR tells the story of the processes used by metropolitan milk distributors in gathering, preparing, and marketing their product. *Philadelphia Inter-State Dairy Council, 219 North Broad Street, Philadelphia, Pa.—Gratis.*

Forestry

DEFORESTED AMERICA, by Major George P. Ahern, with an introduction by Gifford Pinchot, presents the alarmist's views regarding our timber resources, the rate at which those resources are disappearing and what should be done about it. Certain interests may dislike Major Ahern's outspoken word-picture, but everyone interested in forest conservation will read it with real interest. *Deforested America, 1617 Rhode Island Avenue, Washington, D. C.—25 cents.*

THE PROTECTION FORESTS OF THE MISSISSIPPI RIVER WATERSHED AND THEIR PART IN FLOOD PREVENTION (CIRCULAR NO. 37) discusses the natural causes of the devastating floods in the Mississippi River basin. *United States Department of Agriculture, Washington, D. C.—Gratis.*

Safety

WHEN THE EMERGENCY ARISES FOLLOWING A MINE EXPLOSION OR FIRE is a pamphlet describing the equipment for a complete mine rescue station and information regarding the disposition of men and equipment for fire fighting and recovery following a mine explosion. Other booklets on kindred subjects will be furnished gratis by the same firm. *Mine Safety Appliances Company, Pittsburgh, Pa.—Gratis.*

Ready for any emergency, this miner is equipped for rescue work in gas filled mines after an explosion

Thermodynamics

THE INTERNATIONAL TEMPERATURE SCALE, by George K. Burgess, is a reprint from a paper which appeared in the *Bureau of Standards Journal of Research* in October, 1928. *United States Government Printing Office, Washington, D. C.—Five cents.*

DEFINITIONS, NOMENCLATURE, SYMBOLS, AND UNITS FOR HEAT TRANSMISSION, the report of the Committee on Heat Transmission of the National Research Council, is intended to clarify and standardize the terms used in the science of heat transmission. *National Research Council, 40 West 40 Street, New York City.—25 cents.*

Trade

THE WHOLESALE GROCER'S PROBLEMS presents a simple, workable method of computing the cost of handling individual commodities, a diagnosis of the "small order" problem, and considers ways of fitting the inventory to consumer requirements. The text is well illustrated with charts and tables based on actual figures collected by the bureau. *Bureau of Foreign and Domestic Commerce, Washington, D. C.—Gratis.*

GOVERNMENT PUBLICATIONS RELATING TO TEXTILES and PRACTICAL AIDS TO THE TEXTILE INDUSTRY are recently issued bulletins of interest to the manufacturer in the textile field. *Bureau of Foreign and Domestic Commerce, Washington, D. C.—Gratis.*

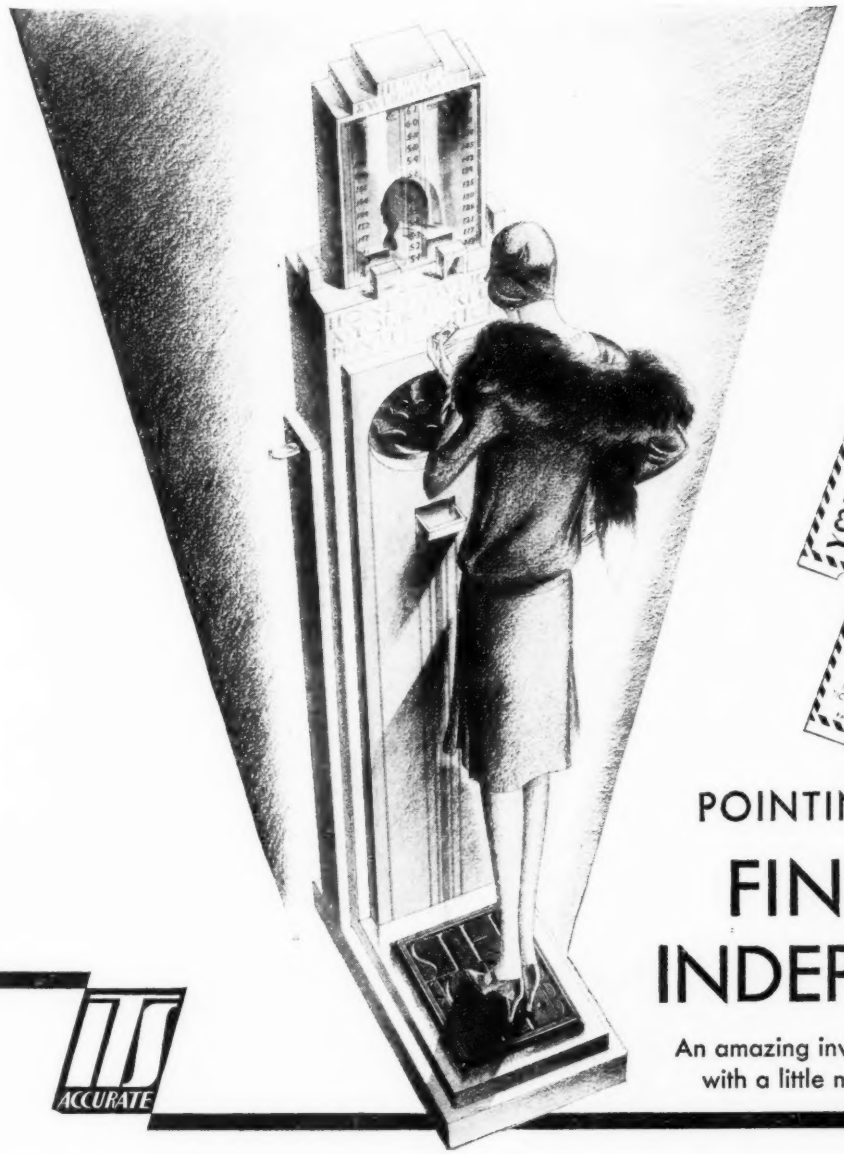
Miscellaneous

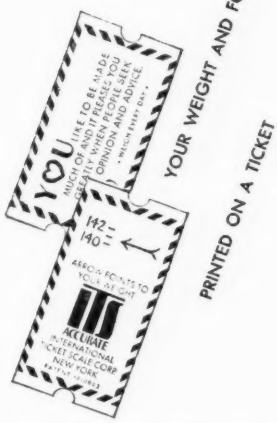
AMATEUR RADIO STATIONS IN THE UNITED STATES lists all amateur stations and experimental, technical, and training school stations. The location of each station is given, the name of its owner, its call signal, and power used. *United States Government Printing Office, Washington, D. C.—25 cents.*

THE POST-WAR MOVEMENTS TO REDUCE NAVAL ARMAMENTS, by John C. Shillock, Jr., has an introduction by Nicholas Murray Butler discussing the Pact of Paris, and a good bibliography on the general subject of international relations and defense. Mr. Shillock's attitude is Wilsonian, optimistic, and inclines toward the opinion that evolution and the League of Nations will eventually bring about the desired result. *Carnegie Endowment for International Peace, 44 Portland Street, Worcester, Mass.—Five cents.*

HOW POWDERED COAL STANDS TODAY is a reprint from an article by Henry Kreisinger published in *Power* some months ago. Consideration is given to many types of new installations and change-overs, where operating efficiency may be increased by using pulverized coal. *Combustion Engineering Corporation, 200 Madison Avenue, New York City.—Gratis.*

TIDAL CURRENT CHARTS, NEW YORK HARBOR, gives a visual schematic representation of the tidal currents at various localities throughout the harbor and a comprehensive view of the tidal current movement for the harbor as a whole. *Director of the United States Coast and Geodetic Survey, Washington, D. C.—25 cents.*





POINTING THE WAY TO FINANCIAL INDEPENDENCE

An amazing investment opportunity for those with a little money and some spare time

The ownership of a chain of International Ticket Scales on location in drug, cigar, and other stores and places, constitutes what is to all intents and purposes a real investment, yielding a handsome return.

You put out to work for you 50 or 100 or 1000 highly developed mechanical workers. There is chain store safety in the distribution of a number of units in that each hundred scales have a hundred different locations. There are chain store profits in that the average profit per scale is multiplied by the number of scales in your chain. Unlike the chain store, you have no payroll. Scales neither eat nor sleep. They take no days off. Day and night they work and serve you, smiling at interested passers-by, holding their coats while they step on inviting platforms, and then give them, printed on a neat ticket, their weight and fate for a small copper penny. They earn and earn and earn while you sleep or play. Chains of International Ticket Scales should earn 40 % to 50 % of their cost annually. Purchased on the deferred payment plan, the scales should readily pay for themselves out of profit, and show in addition, a return of 25 % on the down payment until paid for in two years.

Incidentally, this is the first opportunity for private individuals to participate directly in a proposition of this kind, although the high earnings of ticket printing scales over a period of years are a matter of public knowledge.

Not only is this business profitable and safe, but it is easy and simple. There is little to learn, and little to do. An evening or two a week will care for the average chain of scales. The necessity for mechanical knowledge or the knowledge of scales has been eliminated by our provision for a national service organization with service men in every city and town of importance in the United States.

The owner of a chain of International Ticket Scales operates under our exclusive franchise plan. We are organized to furnish every possible cooperation to every International Ticket Scale operator.

We have prepared a booklet which tells the full story concerning the profit possibilities in a chain of International Ticket Scales, tells step by step how a chain of these scales may be acquired and operated. It tells how you, if you have the necessary qualifications, can with the greatest ease, assure your financial future. It is a booklet for those with a little money and some spare time; for the capitalist; for the individual or group who can control capital.

Write for it today. The coupon below is for your convenience.

International TICKET SCALE CORPORATION

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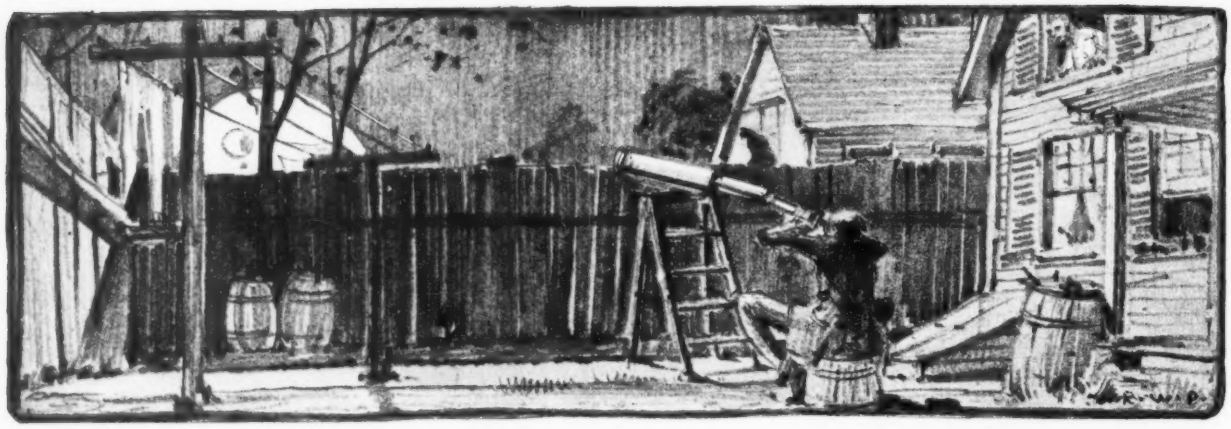
Please send me your proposition.

Name _____

Address _____

To Chain Store Executives: An International Ticket Printing Scale in each of your stores will add a substantial amount to your net profits. For full information, write the Chain Store Manager of the International Ticket Scale Corporation, 17 East 45th Street, New York, N. Y.



The Back Yard Astronomer

A Department Devoted to Interests of the Amateur Telescope Maker

THIS month we illustrate two telescopes made by clergymen. These are the real "sky pilots." They no doubt find heavenly inspiration for sermons—or inspiration for heavenly sermons—at the eyepiece. The first letter comes from Rev. Harold N. Cutler, Rector of St. Paul's Episcopal Church at North Arlington, New Jersey, who states:

"The writer of this note is a clergyman who became tremendously interested in telescope building through your book for amateurs on the subject. My reflector is four inches in aperture, with a focal length of 34 inches and it cost me only $3.45, exclusive of the eye pieces.

"I procured two disks of glass, four inches in diameter, half-inch thick, for 60 cents with ground edges, from a Newark plate glass company. The rouge, carbo, chemicals and so on, made up the rest. Great attention was paid to the fine grinding. Flour emery was used until I was 'blue in the face' but it paid handsomely when it came to the polishing. The radius of the curve was 72 inches but it shortened to 68 inches during the polishing. I will never forget those shadow tests. The first series showed I had a regular well dug in the center of the mirror, so I cut out the center of the tool and soon had a sphere. I used a goodly proportion of beeswax in the pitch lap. The final parabolizing was done in a total of about ten minutes of actual work, but it involved nearly a whole night of waiting and testing—I'll never forget that 'session.'

"A taxi smashed up on our corner, so a piece of its windshield formed the diagonal. The silvering, according to your instructions, went very easily—except, I may add, that I silvered everything in sight.

"The mirror was set in the cover of a coffee can. This was bolted by long screws to the back of an old radio dial. I used this because this type has three rather heavy springs. The whole thing adjusts like a million dollars. This assembly was fixed to the end of the tube with three brass clamps. The tube was stove pipe (20 cents) with a band of heavy galvanized iron on each end.

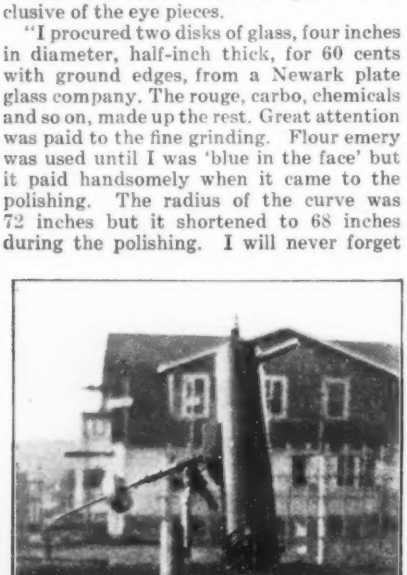
"The mounting is crude—plumber's fittings. A floor flange was bolted to the tube and a piece of half-inch pipe was screwed into it for a declination axis. The latter was inserted in a 'T' which was drilled for set screws and lined with sheet copper to take up the play. The fitting for the eyepiece was a problem until an old drain fitting was found, providing the flange and tube. The finder is a small one dollar telescope but it doesn't work half as well as simply sighting along the tube as one would aim a gun. Later, I replaced the diagonal mirror with a one-inch prism and the result is more than worth the cost. I am using ordinary microscope eyepieces.

"I love to view God's heavens through my reflector. It is a 'grand and glorious feeling' to see Jupiter and her moons and the other wonders with an instrument I have made with my hands."

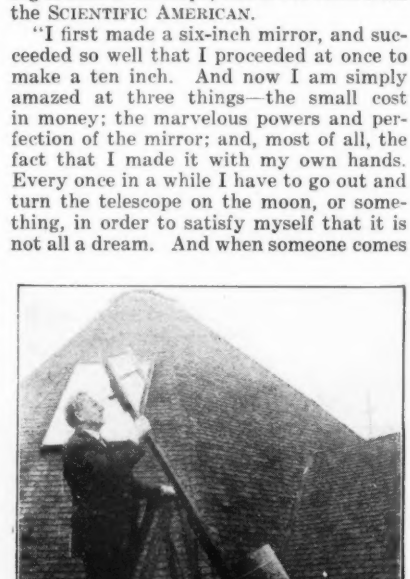
The small dollar telescopes mentioned by the Reverend Mr. Cutler are of little use as a finder because they are of the old Galilean variety, easily recognizable by the outside of the eye lens which is concave. The field of view of a Galilean telescope is limited to about a degree in diameter, while a finder should take in three to five degrees. However, no finder is needed; a simple homemade gunsight with a ring is virtually as satisfactory; or simply aim the tube, as described above.

From another clergyman, Rev. Edwin H. Smith, pastor of the Epworth Methodist Church, 1270 Sanchez Street, San Francisco, California, comes another inspiring communication. "It was my good fortune, about a year ago," he writes, "to learn of the book of instructions, 'Amateur Telescope Making.' The proposition seemed to me altogether incredible, and I think that I would not have attempted the making of such a telescope, had it not come from the SCIENTIFIC AMERICAN.

"I first made a six-inch mirror, and succeeded so well that I proceeded at once to make a ten inch. And now I am simply amazed at three things—the small cost in money; the marvelous powers and perfection of the mirror; and, most of all, the fact that I made it with my own hands. Every once in a while I have to go out and turn the telescope on the moon, or something, in order to satisfy myself that it is not all a dream. And when someone comes



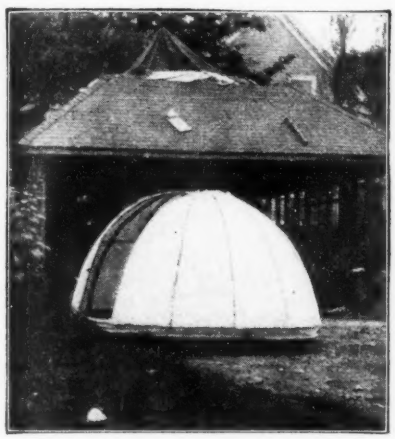
Reverend Cutler's four-inch reflector



Reverend Smith's second reflector

along and questions the cost of materials, only 20 dollars, I can't feel sure of that either, until I go over the bills and check them up again.

"It was my very great pleasure to take the ten-inch telescope up to Camp McCoy, a Y. M. C. A. summer camp for boys in the Sierra Nevada Mountains. There, at an elevation of 6000 feet, and in the transparent atmosphere of the mountains, the definition, at the power of 170 diameters, was clear, sharp, wonderful, amazing. Another very interesting experience was a visit to the Lick Observatory on Mount Hamilton where one thought troubled me. We were to see the planet Saturn through the big 36-inch refractor and I was wondering whether I should have any respect for my little reflector, after looking at Saturn through that big refractor. Well, good fortune or bad, the night was not the best



A small, round observatory dome under construction by B. W. St. Clair, Director of the Standardizing Laboratory of the General Electric Company's laboratory at West Lynn, Massachusetts. The frame of battens is covered with canvas

for 'seeing.' The atmosphere was 'boiling.' So the view of Saturn was not quite clear and only three of the satellites were visible. The result was that I came down the mountain prouder than ever of my little ten-inch telescope."

In addition to the two clergymen whose interesting letters appear above, it is known that several others are at least interested in telescope making, for copies of A. T. M. have been obtained by them.

One rather interesting aspect of amateur telescope making has been the women who have taken it up. Can a woman make a telescope? Well, why not? In the original group of amateurs at Springfield, Vermont, led and instructed in 1921 by Russell W. Porter, there was a woman who made a good mirror. There have also been a number of women purchasers of A. T. M. Here in New York two of these seem to be making out very well, both having brought in their mirrors for our admiration. One took her mirror to "Stellafane" and finished it there.

Mr. Porter reported: "Mrs. W. finished her mirror last night, a very good mirror; the first woman I know of who *thoroughly* understands the knife-edge test, among amateurs." Doubtless the last two words in his statement refer to the fact that a woman telescope maker was for some years

(*Please turn to page* 279)

Industry's Tribute to Yellow Strand

is the continued use of this great high quality wire rope where working conditions are most severe.

But it is for severe working conditions that Yellow Strand is made—those conditions which prove the worth of a wire rope by its sheer ability to stand punishment.

Special steel wire, made abroad to our own specifications is the foundation of Yellow Strand's unquestioned high quality. And 53 years of wire rope making experience enables us to build well on that foundation. One strand colored yellow distinguishes Yellow Strand from all other ropes.

This pioneer wire rope company also makes all standard grades of wire rope.

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Authorized Dealers in all Industrial Localities

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You need a Basline Autowline in your car for emergencies. Made of ¼-inch Yellow Strand wire rope with patented snap hooks for quick attaching. Very strong but small enough to coil flat under a cushion. Ask your accessory dealer.

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MR 463

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For the man who wants to know more about astronomy but has neither the time nor inclination to dig very deep, this volume will be just the thing. Sky maps of great clarity are adapted for studying the constellations without a telescope.

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Mr. Critchlow offers to send one to introduce. Write him today. He also wants County and State Agencies everywhere to make $250 to $1,000 per month.

Industries from Atoms

(*Continued from page* 268)

market an asphalt emulsion paint to be known as "Asphalt Chromate Emulsion" or "Ace" for short. The incorporation of chromates in the emulsion is an added feature calculated to render metal surfaces "passive" to corroding influences. This action of certain salts has been known to chemists for some time and materials used to render metal less susceptible to corrosion are known as inhibitors.

The new paint therefore permits the deposit of a coating of any desired thickness and at the same time incorporates rust inhibitives throughout the depth of the film. It is applied cold with a brush or spray, can be successfully applied to damp surfaces and will dry in from six to eight hours. The resulting film of asphalt is said to be resistent to extremes of temperature and to be relatively water-proof. The principal use for this protective coat at present is for under-ground piping but experiments in other fields indicate that it will find application in a wide variety of uses.

Profits Squeezed Out of Waste Lemons

AN example of the success which can be attained by the application of research to the problem of agricultural waste is furnished by the citrus fruits industry. The disposal of cull or waste fruits was a pressing problem since it involved not merely a waste of products on which time and labor had been expended but also an additional expense for disposal of the material. Research by the Bureau of Chemistry developed uses for the waste lemons, oranges, and so forth, in the manufacture of citric acid, lemon and orange oils, pectin, and the like. A profit of approximately one million dollars per year was thus realized and the citrus fruit grower, instead of paying a dollar per ton for disposing of his waste material, receives twelve dollars per ton from the by-product manufacture.

Robin Hood's Merry Men Popularize Primitive Dye

IN his pamphlet, one of the Woodbrooke Essays, "A Primitive Dyestuff," Dr. Rendel Harris gives some interesting notes and reflections on the woad plant, the earliest dye-plant known in England. When the art of dyeing with woad became a leading industry, it was the custom to treat the blue dye with an alkaline or ammoniacal liquor or lye, which changed the blue into a vivid green, known to the ancients as lincoln green, such as Robin Hood and his men wore in the recesses of Sherwood Forest. Caesar, in his history of the Gallic Wars, describes the Britons as dyeing their bodies with woad, "a substance that yields a bluish pigment and in battle greatly increases the wildness of their look." Up to a few years ago the woad plant was still cultivated in England but the old race of nomadic woadmen, a kind of agricultural gipsy class, has practically disappeared because of the achievements of modern chemistry in producing better and faster dyes by organic synthesis.

In contrast to the efficient, large-scale production of modern dyes, the description of the old fashioned method of extracting woad is interesting. The woad was cut by women and girls, carted to the farm,

What Did COPERNICAS GALILEO NEWTON

actually say when they announced their discoveries to the world?

Read their actual words in

A Source Book in Astronomy

By PROF. SHEPLEY and his assistant HOWARTH of Harvard Observatory

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SCIENTIFIC AMERICAN
24 West 40th Street
New York, N. Y.

and ground at once. The mill, worked by an engine, consisted of three large revolving wheels that described a circle, and two running flanges, one on the outer and one on the inner rim of the wheel track that kept the woad in place. The leaves were piled within the circle and pitched under the wheels a little at a time by two men who then brushed all stray leaves on to the track. The crushed woad was put into two wooden vats. A pipe carried away any juice that ran out, as this is not of use. The next day the woad was made into balls by hand; and these balls were laid out on racks where they would stay until the following December. Then all the woad would be packed into casks and sent to Leeds, where it passed into the hands of the dye-merchant and the dyer. The government still insists on certain cloth for its use being dyed with woad; hence the activity of the firm in Leeds.

Chemists Strive for Extreme Low Temperature

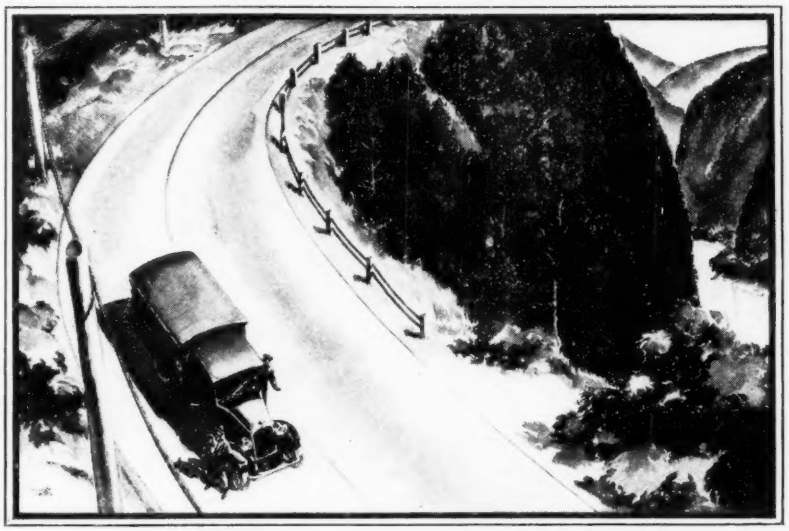
THE efforts of scientists to achieve extremely high temperatures are generally known and have been applied in certain industrial operations. Less is known of the work of another group of scientists who are striving to produce extreme cold. Professor B. S. Hopkins of the University of Illinois recently told the Institute of Chemistry about his attempts to produce "absolute zero," which is 273 degrees below zero, Centigrade. At absolute zero it is believed that the molecules of matter cease entirely the vibration which characterizes them at ordinary temperatures and the character of the substance is thereby entirely changed. Professor Hopkins is attempting to achieve this extreme frigidity by the use of a substance called "galolinium sulfate."

Chemistry is developing the field of "rare earths." Stripping the elements of their technical names—cerium, thorium neodymium—these rare earths are now used in the manufacture of electric light and radio bulbs, cast iron, cigaret lighters, seasickness cures, fine grades of optical glasses for microscopes and telescopes, antiseptic dressings, porcelain and china glazes, and allied lines. The big problem confronting the "rare earth" chemist is that of lowering the temperature to "absolute zero."

Corrosion-Resisting Flooring

WHILE the ordinary concrete floor is long-lived and wear-resisting in most types of factory, it is readily susceptible to chemical attack and disintegration when used in places where there is constant exposure to acid. Thus the foundations of a building may also be attacked in time. A type of flooring is needed which can resist unavoidable spilling of acid and can also withstand heavy loads and hard wear.

Such properties are claimed for Prodorite, a compound for flooring which has remarkable resistance to acid attack. It has, according to a British National Physics Laboratory report, a crushing strength of 6000 pounds per square inch, and possesses a resistance to abrasion double that of matured 2 to 1 sand-Portland cement concrete. At 60 degrees, Centigrade, the material is stated to withstand concentrated hydrochloric acid, 65 percent sulfuric acid, and 15 percent nitric acid. It also resists the above acids at greater concentrations when cold.



Getting there ahead of the trouble

An Advertisement of the American Telephone and Telegraph Company

DURING the afternoon of March 17, 1928, an alarm bell rang in a telephone test station in the heart of the Alleghany mountains. This meant that a puncture had been made in the air-tight sheath of a busy inter-city cable. The men on duty knew that the injury was somewhere within 50 miles.

Highly developed locating devices were instantly applied and in sixty-five minutes the trouble spot was located. By 7.15 in the evening, before the break in the sheath had affected service on any of the 248 pairs of wires in the cable, the repairs had been made. Because of the preliminary warning on the indicator wire and the locating devices that enabled the test station to tell the repair crew just where it would find the trouble, not one conversation was interrupted. This special alarm system is one of the many mechanical and electrical wonders developed by Bell System engineers to guard telephone conversations. The apparatus is placed along the cable routes at intervals of 100 miles. It gives instant warning day or night of any disturbance to the cable within 50 miles in either direction. Automatic warning signals, electrical locating devices, constant testing of all switchboard apparatus and circuits—these are some of the ceaseless efforts that so effectively reduced interruptions to service on Bell lines in 1928.

There is no standing still in the Bell System. Constant progress in accuracy and better service at the lowest cost is its goal.

"THE TELEPHONE BOOKS ARE THE DIRECTORY OF THE NATION"

Why PURE CHEMICALS CORRECT ALL FEED WATER TROUBLE!

They prevent precipitation, control concentration, stop and prevent corrosion and pitting, remove oil or grease (curl-onized or not), act uniformly under all temperatures and pressures, everything that is required to successfully treat boiler feed water. Only Pure *Corrective Chemicals* do this.
Pamphlet on Request

UNISOL MANUFACTURING CO.
Sime, Darby & Co., Ltd., Singapore, S. S. Agents for Straits Settlements. Jersey City, N. J., U.S.A.

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Big demand for 5 and 10c store Novelties, Ashtrays, Toy Soldiers, Animals, Auto Radiator Ornaments, etc. We cooperate in selling goods you make; also buy these from you. Small investment needed to start and we help you build up. We furnish COMPLETE OUTFITS and start you in well-paying business. Absolutely NO EXPERIENCE and no special place needed. A chance of a life-time for man with small capital. Write AT ONCE if you mean strictly business and want to handle wholesale orders now being placed.
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8¾ pounds, 43 inches long, 24 inch barrel. Offered without bayonet, $19.50. Packing charge 50c extra. Ball cartridges $3.50 per 100. New catalog, illustrated, 380 pages of Army-Navy equipment, pistols, guns, uniforms, saddles, for 50 cents.
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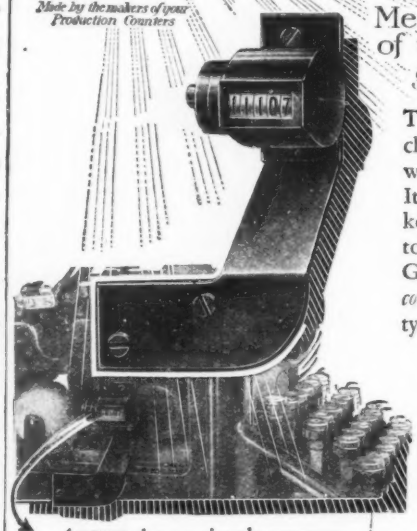

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Synthetic Ammonia Abroad

FOLLOWING Germany's example, the principal French coal mines are developing the utilization of their by-products, with a view to reducing the cost price of coal. Production of synthetic ammonia through the Claude and Casale processes is increasing in France, and 10 mining companies have already started this production, either directly or through branch companies.

The present production capacity of synthetic ammonia in France is said to be between 200 and 225 metric tons daily. This production policy has facilitated the preparation of sulfate of ammonia for agricultural uses, 182,000 tons being produced from all sources in 1927, as compared with 77,000 tons in 1913, according to Assistant Commercial Attaché D. J. Reagan, Paris.

Vanillin From Sulfite Liquor

FOR years, paper manufacturers have sought some practical use for the ill-smelling sulfite liquor that results from the manufacture of cellulose from wood. To imagine this waste product as the source of a sweet-smelling, tasty, flavoring extract seems far fetched, yet reports from Hamburg, Germany, state that vanillin has been produced in considerable quantities from sulfite liquor.

Special Finishes for Aircraft

THE aviation industry, now in its infancy, may be expected to continue its spectacular growth. Likewise, the chemist may be expected to contribute to the development of better fuel and better materials of construction, but no opportunity offers more immediate promise than in the further development of materials and methods of finishing, says R. C. Martin, in a recent issue of *Chemical and Metallurgical Engineering*.

Two distinct types of materials used on the wings and fuselage of airplanes are known as "acetate dope" and "nitrate dope." Whenever the word "dope" is used, it generally refers to a combination of a cellulose derivative blended with the common esters such as ethyl and butyl acetate and solvents like acetone and benzol.

Mr. Martin predicts that airplanes will soon be as attractively finished in colored lacquers as modern automobiles.

Luminous Pressure Waves

PHOTOGRAPHY of the phenomena taking place when a cartridge of dynamite is detonated has shown the existence of luminous waves propagated at high speed in the air surrounding the explosive. It was at first thought by United States Bureau of Mines engineers, conducting these experiments, that these

waves were merely reacting gases projected from the explosive, but further work in which the air around the stick has been replaced by hydrogen or carbon dioxide has made it seem probable that these are really pressure waves at such high temperatures that the gas actually radiates in the visible region of the spectrum. The work is part of a program of investigation by the Bureau of Mines of the sensitivity of explosives to detonation by influence.

Can Chemistry Improve on Roast Beef?

A GLIMPSE into future possibilities of industrial chemistry in utilizing agricultural products was given by Dr. C. M. A. Stine, Chemical Director of E. I. duPont de Nemours and Company, speaking before the American Farm Bureau Federation in Chicago. Dr. Stine pointed out that it requires 100 pounds of foodstuffs to produce three pounds of beef, and three acres of land to support a cow, but thousands of pounds of solid yeast protein may be developed and separated in a few hours in a very limited space by growing yeast upon such fermentable agricultural waste as molasses, for example.

"Whether we shall eventually take appreciable amounts of our protein in the form of some product such as a yeast protein instead of beef, I do not know," Dr. Stine declared. "This merely serves to illustrate the tremendous, revolutionary changes which applied science is capable of bringing about in the lives of men. I am sure that if you had told the gas and coke manufacturer of the early days that his troublesome and stinking coal tar, which he had to get rid of, would some day become the raw material for the production of a whole world of colors and drugs and medicinal products, he would have been no less skeptical than you may be today when I talk of the possibility that science, applied to the problems of the best and most economical utilization of land for crop purposes, will evolve new uses for entirely new crops which will automatically take care of a number of our problems today such as the utilization of certain agricultural wastes. The agricultural wastes of today will no longer be produced or will be produced in a much smaller volume."

Making Luminous Paint From Radium

A CASE of radium "poisoning" of employees of a maker of luminous clock dials, et cetera, attracted much notice in the metropolitan press some time ago. The employees affected brought suit for damages on the contention that they were doomed, by radium poisoning, to a slow but certain death. The details of this dramatic litigation were informative to many who never realized that radium is actually used in luminous paint.

Luminous paint is nearly 300 years old, although it was not until after the discovery of radium that permanently luminous paints were made commercially. The material consists fundamentally of a phosphorescent body mixed with a suitable radioactive substance. Zinc sulfide is used for the former and either radium or mesothorium is used as the radioactive substance.

A solution of zinc chloride is prepared from the metal or oxide, purified and then precipitated as sulfide, which is dried and ground. To the dried sulfide is added the copper, the proportion usually being between 1 part in 10,000 or 1 part in 50,000. The copper is added in the form of a dilute solution of copper sulfate. After this addition, the sulfide is again dried and ground. The dried sulfide is next heated to 1300 to 1400 degrees, Centigrade, giving small hexagonal crystals which are rubbed through a sieve without grinding. In incorporation with either radium or mesothorium the tube is opened and the desired quantity mixed dry or added to the moistened sulfide in solution. The mixture is then dried at ordinary temperature, preferably in a vacuum over sulfuric acid. To apply the luminous powder, it is mixed to form a thick paste with a suitable transparent varnish.

The freshly mixed compound does not immediately attain its maximum luminosity, but this increases gradually for a period usually between 10 and 20 days. After this the luminosity begins to fall, at first gradually, then more rapidly and finally gradually again.

Heavy Liquids Used in Ore Testing

HEAVY liquids have come into use in ore-dressing investigations, as they make possible the separation of an ore into its specific-gravity components. Some heavy liquids become discolored after use, and the lack of transparency impairs their value. Since they are expensive, it is desirable to reclaim them. In Serial Number 2897 by R. G. O'Meara and J. Bruce Clemmer, recently issued by the United States Bureau of Mines, Department of Commerce, methods of preparing and cleaning some common heavy liquids used in ore cleaning are discussed. The liquids dealt with are acetylene tetrabromide, methylene iodide, thallium formate, and thallium malonate-formate.

Bacteria Used to Measure Oxygen

TURNING the personal habits of certain bacteria to useful account is an old trick of the chemist. The latest wrinkle in this field however is reported in *Science* which says that by using luminous bacteria as an indicator, the diffusion of oxygen through a membrane may be readily viewed. A test tube is completely filled with a dilute suspension of the bacteria and stoppered. With the insertion of a glass stopper the luminescence disappears completely because oxygen is necessary to produce it. If, however, a membrane be used as a stopper, the bacteria in contact with the membrane or within a short distance of it remain active and glow visibly. A comparison of the luminous columns will give an approximate estimate of the amount of oxygen diffusing through the membrane.

Hazards in Handling Sulphuric Acid in Drums

NEARLY every manufacturer handles sulfuric acid at some time, for it is probably the most universally used chemical. It is generally handled in iron drums and is not ordinarily regarded as an explosion hazard. Not long ago, however, two lives were lost in the explosion of a drum of concentrated acid. The "bung" which had been loosened to provide a vent, corroded so as to seal the hole and the

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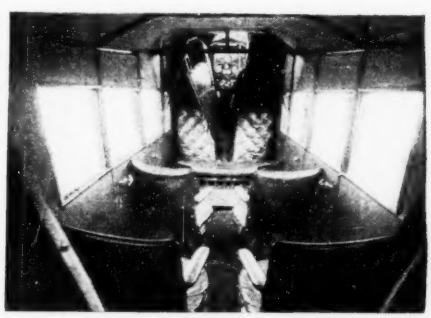

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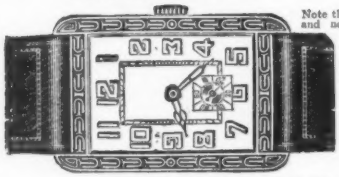

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hydrogen generated by the action of the acid on the iron built up to a pressure which finally rent the welded side of the drum. As a result of the investigation which followed this accident, *Chemical Markets* publishes a warning to users of sulfuric acid as follows:

Sulfuric acid should not be stored in drums, this for the reason that the drums are not of heavy enough gage metal to stand the corrosion that is bound to occur, and in the second place as the reaction goes on between the acid and the iron, a vent, unless it is rigidly inspected, will be sealed up by the sulfite, with the possible result described above.

Chemistry Contributes to Complexions

AMONG the cosmetics that compete for a place on milady's dressing table, a newcomer has recently made its appearance—facial cream that will wash off with water. Let us not pause here to enumerate the manifold blessings conferred by this boon to womankind—the advertisements will cover that phase of the subject fully. Instead let us stick inquisitive noses into the attractive jar and find out how chemistry has provided this new passport to female pulchritude.

It all goes back to that red-letter day in American chemistry when one of our greatest chemical companies decided to venture into the field of commercial synthesis of a hitherto rare series of products from natural gas. From that venture has resulted one of the most remarkable developments in industrial chemistry, the creation of an industry which daily produces tons of compounds that a decade ago were hardly more than laboratory curiosities. One of the latest synthetic compounds built up from ethane gas as a starting point is triethanolamine, a colorless, viscous liquid with an ammoniacal odor, freely soluble in water and strongly basic in nature. This is the secret of water soluble face cream.

The product now available as commercial triethanolamine is, in fact, a mixture containing approximately 70 to 75 percent triethanolamine, 20 to 25 percent diethanolamine and 0 to 5 percent monoethanolamine. It reacts both as an organic base and as an alcohol. It combines freely with fatty acids such as oleic and stearic to form soaps that are readily soluble not only in water but also in gasoline and oil. Small quantities of such soaps will emulsify a mixture of mineral oil and water to yield an excellent cutting oil. Shaving soaps and facial creams that can be washed off with water can readily be produced from the same soaps.

Triethanolamine can replace, in whole or in part, various organic alcohols such as phenol or glycerine in the manufacture of synthetic resins. Small quantities of triethanolamine added to organic liquids greatly increase their penetration into cellular materials such as wood or fibers. This increased penetration results partly from a lowering of the surface tension of the liquid, a property which triethanolamine exhibits in a marked degree. Finally the ethanolamines are among the most hygroscopic organic compounds known. Although monoethanolamine is outstanding in this respect, commercial triethanolamine is far more hygroscopic than either glycol or glycerine.

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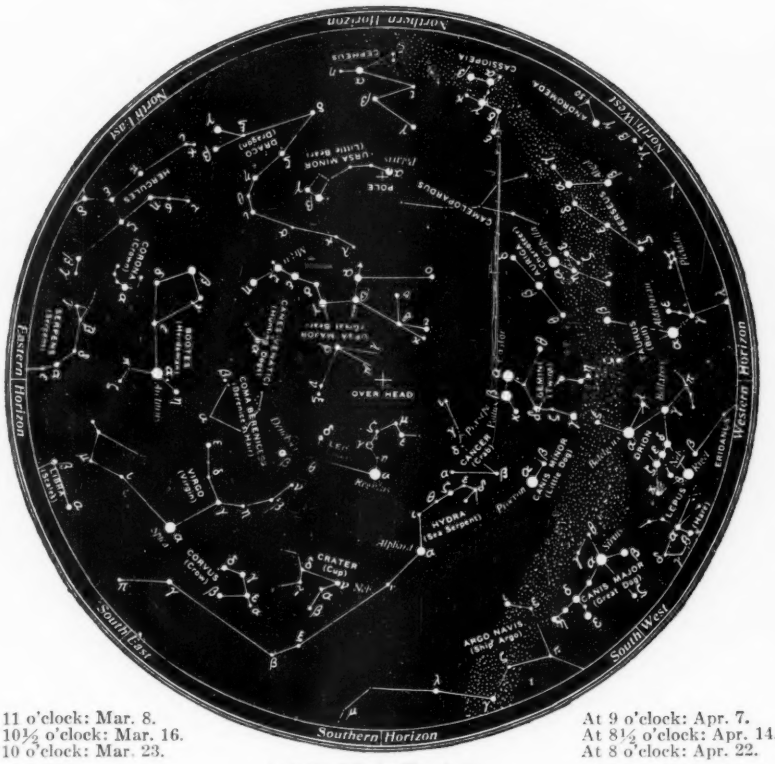
The Backyard Astronomer

(*Continued from page 273*)

employed professionally at the famous Brashear shops in Pittsburgh. It is hoped that those of the amateurs who are not already peeved because women have recently invaded the trades and professions, and ruined the sacred clubbiness of our barber shops, will throw down the challenge to their wives, sisters and others to make a mirror. We would like, say a year hence, to devote the whole Back Yard of one issue to telescopes made by women—they, of course, to appear in the pictures for art's sake.—*A. G. I., Tel. Ed.*

The Heavens in March

By PROF. HENRY NORRIS RUSSELL, Ph.D



At 11 o'clock: Mar. 8.
At 10½ o'clock: Mar. 16.
At 10 o'clock: Mar. 23.

At 9 o'clock: Apr. 7.
At 8½ o'clock: Apr. 14.
At 8 o'clock: Apr. 22.

At 9:30 o'clock: March 29.

NIGHT SKY: MARCH AND APRIL

MERCURY is a morning star all through March. He is farthest from the sun (in the sky) on the 5th, being 27° 14′ away; which is the maximum possible distance since he is at his greatest *real* distance from the sun only a week later. He would be conspicuous in the early part of the month if he were not south of the sun; and even as it is he rises before 5:30 A.M and should be easily visible in the dawn.

Venus is an evening star and at her greatest brilliancy. She appears telescopically as a rather wide crescent 40 seconds from horn to horn. This can be seen with a good binocular magnifying ten times or more. To the unaided eye she is 12 times brighter than Sirius and dominates the evening sky, remaining in sight till 9:30 P.M.

Mars has by this time been left far behind by the earth's more rapid orbital motion and is only one sixth as bright as he was when the year began. He is still in Gemini, retracing his path of the last two months pretty closely; but has fallen far to the westward in the sky, so that he is in quadrature on the 28th and is due south at 6 P.M. He is far north and remains in sight until 2 A.M. in the middle of the month.

Jupiter is an evening star and sets between 9 and 10 P.M.

Saturn is visible in the morning and comes into quadrature west of the sun on the 21st. He is, however, so far south that he does not rise till nearly 2 A.M.

Uranus is in conjunction with the sun on the 28th and is practically invisible. Neptune is in Leo just past opposition and will be observable telescopically.

The moon is in her last quarter at 6 A.M. on March 3rd; new at 4 A.M. on the 11th; in her first quarter at 3 A.M. on the 18th and full at the same hour on the 25th. She is nearest the earth on the 17th, and farthest away on the 24th. While on her circuit of the skies she passes by Saturn on the 4th, Mercury on the 8th, Uranus on the 12th, Venus and Jupiter on the 14th, Mars on the 18th, and Neptune on the 22nd. On the 18th she occults Mars, hiding the planet for three quarters of an hour, but the occultation occurs in the daytime for American observers. As seen from Washington, Mars is behind the moon when the latter rises, and comes out at 11:25 A.M., local time, when both are so low that the emersion will be hard to see unless with a telescope.

We may note, finally, that at 9:35 P.M. on March 20th, the sun crosses the celestial equator and "spring begins."

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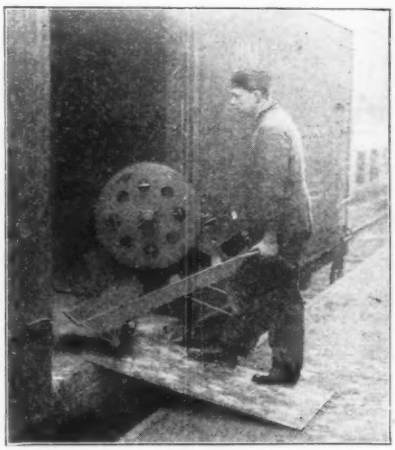
The Scientific American Digest

(*Continued from page 265*)

confined to the lading itself, much in the same manner as one would tie a bundle of sticks together with rope.

Early experiments with Unit-Load, which were made on cylindrical containers such as barrels, drums, newsprint rolls, proved that the idea was sound—even the first shipment was a complete success. The news spread rapidly; the railroads and inspection bureaus got back of it; and today this plan of bracing has been perfected.

Among the products which are now braced in this manner in addition to barrels



Reels, clamping tools, et cetera, are all carried on a small hand truck

and newsprint previously spoken of are: strawboard, box board, tin cans, roofing paper, crated materials such as stoves, furniture, lineoleum, and the like, radiators, enamelware, such as bath tubs, lavatories, and sinks, paint products, white and red lead, steel cylinders, milk cans, mixed loads consisting of pails, boxes, cans, et cetera, automobile engines, cold rolled strip steel, sheet steel, fruit boxes, and many others too numerous to list. During 1928 well over 350,000 carloads of freight of all kinds were braced with Unit-Load, and the results are said to have been uniformly satisfactory.

The advantages of the Unit-Load method of bracing are many, both from the standpoint of the shipper, the railroads, and the consignee. Damage is practically eliminated, and the cost of bracing material and time of loading and unloading is greatly reduced.

Illustrations presented with this article afford the reader a fair idea of the principle of Unit-Load and its simplicity, as contrasted to the slow, costly, and notably inefficient practice of blocking with heavy timbers.

Corns and Shoe Trees

"COVERINGS for the feet, and corns" appear to make a combination which man has great difficulty in avoiding. In general the shoe has to be accepted as it is provided for us by the manufacturer. The corn, commonly defined as "horny induration of skin from pressure" follows as an adaptation response of the foot to the shoe. Since it is pressure and friction that cause the difficulty, some special provisions should be made to avoid these and so to obviate, if not the corn, at least its

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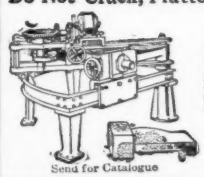
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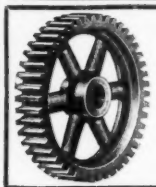
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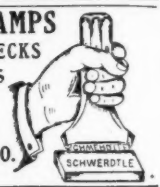

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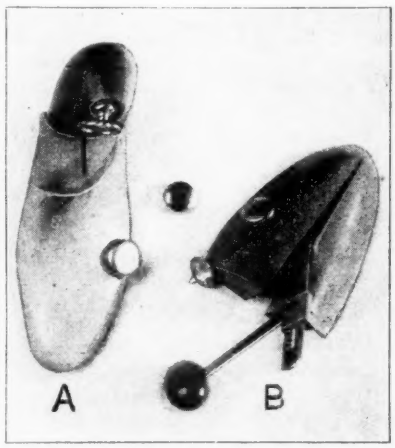
aggravated and often exaggerated presence.

Everyone knows that if a shoe seems particularly tight and uncomfortable at certain spots, subjecting it to a special stretching process often gives marked relief. But in such a case the leather usually does not remain permanently stretched as at the time the stretcher was applied.

A simple arrangement that will assist in combating the aggravated development of corns is illustrated here. Into a wooden shoetree is driven an ordinary small dome



Shoe trees equipped with domes for stretching shoes at tight points

slider such as is used on the bottom of chair legs. Obviously the shoe-tree may be either a reproduction of the original shoe last fitting the shoe snugly as seen in A in the figure, or of the adjustable variety, B. The action of the two kinds, A and B, in forming the leather into a comfortable foot covering will be about the same in either case.

The small metal sliders are sold under the name of "Domes of Silence." It is very easy to locate a number of these at the proper spots. Handling the matter in this way obviates the necessity of stretching the shoe in the customary way which is often done almost to the breaking point, and furthermore the shoe need not be disfigured. The leather becomes accustomed to the modified shape of the improved shoe-tree and if the tree is placed in the shoe regularly every night, the individual may experience very great relief. In some instances the corn has been observed practically to disappear under these conditions.

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FOLLOWING the announcement made during November that the United States airplane carrier *Lexington* had developed, in a test run, a speed of 34.82 knots, a recent report from San Pedro, California, states that the *Saratoga*, sister ship of the *Lexington*, has exceeded this record. The *Saratoga* achieved a rate of 34.99 knots, or approximately 40.5 miles per hour.

In order to develop this speed for a vessel of such great weight (33,000 tons), the General Electric motors had to supply 215,581 horsepower to the propeller shafts. It is estimated that, at this rate of speed, it would be impossible to stop the ship in a distance of much less than a mile.

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Commercial Property News

A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

The Patent Office Falls Behind

THIS department heretofore has called attention to the increase in the number of patent applications and the accompanying *decrease* in the number of patents issued. Many explanations have been offered, one of them being the theory that the margin between the things we know and the applications we have made of our knowledge rapidly is narrowing. In other words, within the limits of our knowledge there are fewer things left to invent.

These are the figures which seemed to need an explanation:

YEAR	APPLICATIONS	PATENTS
1926.....	80,682	46,464
1927.....	84,511	43,244
1928.....	88,482	41,067

The following figures throw a flood of light upon the situation:

APPLICATIONS AWAITING ACTION	
1926.....	43,765
1927.....	64,646
1928.....	106,575

The real explanation, then, seems to be simply that the Patent Office cannot keep up with the enormous volume of cases which it is called upon to handle. The more applications it receives, the further behind it drops, and the fewer patents it issues. For the sake of the inventors of the country and the industries affected by their work, something should be done about it.

The fault lies not with the efficient and conscientious, but over-worked staff of workers in the Patent Office, but with Congress for failing to provide adequate funds. Commissioner Robertson stated:

"The work of the Patent Office may be divided into two classes—one, the usual clerical work, and the other, the technical, scientific work performed by the examining corps. As will be hereinafter shown, the work of the 600 clerical employees is practically up to date, but the scientific, technical work in the 56 patent-examining divisions is not and can not be kept current when it keeps on increasing year by year as it has, unless the force of technical examiners is correspondingly augmented. Thus, in 1925, excluding design and trademark cases, the office received 77,000 applications; in 1926, 80,000 applications; in 1927, 84,511 applications; and in the year just closed 88,482 applications. Notwithstanding this great increase of work, our force of examiners has been smaller than in 1925.

"To add to the increase of work as above specified, the law was changed about a year ago to provide that applicants must amend their applications after official action thereon within six months instead of a year as formerly, and this has vastly increased the work. This, added to the 3000 more new applications, has resulted in the reciept of from 800 to 1000 cases per week more than the personnel could handle, with the result that while there were 64,646 patent applications awaiting official action one year ago, that number has grown to 106,575, a point never before reached in the history of the Patent Office. Moreover, the receipt of this vast amount of business has resulted in the examiners going further behind in their dates. Thus, two years ago when our force of examiners was 50 larger than now, a number of the divisions of the office were acting on cases within two months after they were filed, with an average of two and one half months; a year ago it was three and one half months, and now the average has reached six months. This condition should not be permitted to continue.

"The Bureau of the Budget and Congress have come to our relief by providing for the coming year six new divisions, with 80 additional employees. The Public Buildings Commission has also relieved us by providing additional space in the old Land Office Building to house these additional employees. By the time these employees become trained as many more will have resigned and their places been filled by green men, so it will not be possible to make much impression on the mountain of work now piled up. With more than 106,000 cases awaiting official action, there is sufficient work on hand to occupy the entire force for a year even if no work were received, but the new work in unprecedented amount keeps coming in and must be taken care of."

Safety in Secrecy

IF you have a valuable invention, don't let the knowledge of it escape until you have applied for a patent. Don't use it publicly; if it should be in public use for two years before you apply for your patent, the government cannot under the law grant you a patent, even though the fact that you are the sole and original inventor may be indisputable.

How important proper safeguards to insure secrecy may be was illustrated recently in the infringement suit brought by the Peerless Roll Leaf Company, Inc., against H. Griffin and Sons Company. The purpose of the patented machine was to feed metallized transfer strips of paper to a stamping press for use in printing titles upon book covers. There had been other such machines before, but the patent in suit, Number 1,526,209, was for an improvement.

The Griffin company appeared with a machine invented by Richard Lange, but which was said to infringe the Grupe claims. When the case came to trial the Griffin company showed that an associated company of the Peerless company, the Ebees Company, had made three machines embodying the invention more than two years earlier than March 31, 1924, the date of the application for the patent. These machines had been turned over to the Sterling Company, another associated organization, which used them commercially during 1921 and 1922. Upon this point there was no dispute.

The Sterling Company, however, was careful not to let the public know how the machines were being used. They were not sold, nor were they displayed to any persons who came to the factory. Only three employes were admitted to the room where they were kept, one Mangold, who was in charge of them, with the aid first of one,

Many inventors, who cannot afford to advertise, display their devices for sale on the boulevards of Paris during the Christmas holidays. This picture shows an inventor demonstrating his bottle opener to prospective purchasers. The Prefect of Police grants permission to set up the stands every Christmas

and later of two, assistants. The plaintiff was "right secretive about them," "partitioned the machines off in a little room on the floor" and kept them secret "by isolating them." Access to them was possible only by crossing a bridge between two buildings. Moreover, the Sterling Company was an experimental department of the Boucher Company, and it was to test out the product that the Sterling Company used them. On the other hand they were used to ornament paper boxes and the like, which were shown freely and sold in quantity. Customers for the products were not, however, shown the machines themselves.

In deciding that the invention had been kept a secret and that, therefore, the patent which was infringed, was a valid patent, Judge Learned Hand, of the Circuit Court of Appeals for the Second Circuit, said:

"The word 'public' means more than that the use shall not be experimental; it is possible, even after the time of experiment has passed, to practice the invention without abandonment. An inventor working by himself presents a simple case, but we cannot suppose that his rights are greater than those of a company. There must be some way by which they can privately practice their inventions as well as he, and yet any practice involves the knowledge of some employes.

"When the number of these is limited to as few as are necessary to practice it at all, the customers and the public generally are excluded, and adequate precautions are taken to prevent dispersion of the knowledge until at least two years before application is made, it seems to us enough, whether a formal pledge of secrecy be exacted or not. Those workmen who will keep it do not need it; those who will not, it will not bind.

"We do not mean that if in fact knowledge leaks out, the invention may not be lost; as to that we say nothing. But when, as here, adequate means are taken to confine all information as closely as is consistent with any exploitation at all, and when so far as appears they are successful, the knowledge of the necessary workmen not explicitly pledged to secrecy does not make the use public. The sale of the product was irrelevant, since no knowledge could possibly be acquired of the machine in that way."

Another "Emergency" Case

THE Government and the courts are still untangling patent snarls caused by the World War and in the process new interpretations are made of the rights of inventors. The circumstances surrounding the claim of Carl G. Allgrund against the United States provide an interesting example.

Allgrund is a skilled machinist. For more than 16 years he occupied a responsible position with the Bethlehem Steel Company in its gunshop department and had personal charge of tool making, sights, rifle heads, and so on. In June 1917, he became superintendent of the gun-finishing department of the Symington-Anderson Company of Rochester. This company was at that time manufacturing guns for the government.

Guns had to be made in a hurry in those days and any invention that speeded up their manufacture was valuable. Allgrund conceived the idea of inventing a tool which would facilitate the performance of the rifling operation, would improve it in the way of accuracy, and would do this in less time and at less expense. He showed the drawings to his employer, who authorized an expenditure of 500 dollars to develop it. By February 1, 1918, the newly invented tool was put in operation and thereafter all the guns of the company were made with it.

On February 23, 1918, Allgrund applied for a patent, his employers disavowing any claim to the invention. On June 29, 1918, the Commissioner of Patents rejected all the claims in the patent application and followed this action on July 2, with a written injunction of secrecy, saying, "Your application has been found to contain subject matter which might be detrimental to public safety or assist the enemy in this present war." The Federal Trade Commission followed with a similar secrecy order.

But Allgrunn wanted his patent; he made amendments to his application. This time the War Department sought to intervene by filing a petition to take testimony to show prior public use of the invention. Then the war ended, the secrecy orders were rescinded, and on July 22, 1919, Allgrund's patent issued. Meantime, however, four large gun manufacturers, authorized by the government, had been using Allgrund's invention. He made a claim on the government for royalties.

In upholding Allgrund's claims, Chief Justice Booth of the Court of Claims, declares:

"Secrecy is enjoined upon the patentee. We have found the secrecy order to have been observed. The patentee discovers that his invention has become known to and is in use by government contractors other than those who have permission to use it; he at once notifies the government of this use and at the same time tenders his invention for use. The government contractors thereafter continued the use of the invention. Surely opportunity was afforded the government by the tender to discontinue its use. It was but a formal matter for the government to notify the contractors of plaintiff's tender and claims. On the contrary, with full knowledge of the situation, the government at no time did more than to attempt after use to prevent the granting of plaintiff's patent.

"The officers of the government knew the law and were conscious of the legal consequences of using the invention if they continued to use it. What were those consequences? One at least was a liability to compensate the patentee for the use of his invention from the date of the use. The government may not disclaim knowledge of the invention, nor of the plaintiff's future intention to seek compensation. The plaintiff had permission to use the invention and disclose it to his employers and one other company. Therefore it seems to us that the authorized use preceding the tender, if continued after the tender, brings the plaintiff within the relief intended by the act."

Patents Recently Issued

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Pertaining to Apparel

SUPPORTER FOR WEARING APPAREL—Which permits free bodily movement without injury to the clothing or discomfort to the wearer, and obviates the use of elastics, adapted for hip boots and children's hose. Patent 1694735. James T. Eskridge, La Jara, Colorado.

Designs

DESIGN FOR A DRINK STAND—Patent 76896. Peter E. Ryerson, c/o Imperial Valley Concrete Co., Holtville, Calif.

DESIGN FOR A SHOE—Patent 77082. Leo J. Fitz Harris, c/o Franklin Simon & Co., 38th St. & 5th Ave., New York, N. Y.

DESIGN FOR A VALVE FITTING—Patent 77028. Emil Price and William A. Pfister, 2929 Humboldt St., Los Angeles, Calif.

DESIGN FOR A GOBLET—Patent 77227. George Dougherty, c/o Economy Glass Co., Morgantown, West Va.

DESIGN FOR A VEGETABLE CABINET—Patent 77233. Max Halpert, c/o M. H. Metal Product Co. 1154 Flushing Ave., Brooklyn, N. Y. Attention G. T. Latimer.

DESIGN FOR A LAMP STANDARD—Patent 77245. Joseph Lieberman, 39 W. 22 St., Bayonne, N. J.

Electrical Devices

INSULATING SUPPORT FOR ELECTRIC RESISTANCE HEATING ELEMENT—So formed as to prevent over heating of the heating element, and at the same time to induce a circulation of air which promotes a freer radiation. Patent 1695234. Louis J. Fuller, c/o Duparquet, Haut & Moneuse Co., 108 W. 22 St., New York, N. Y.

RECTIFYING SYSTEM—An electric system especially designed for eliminating alternating current hum, rendering the spark gap conductive during only one-half of the cycle of the supply line. Patent 1694837. Fletcher L. Walker, Jr., Westwood, Calif.

Of General Interest

WATER COOLER—Employing a supporting olla, the olla and bottle being sealed against air entering either receptacle except in a manner to be filtered of its impurities. Patent 1692066. Arthur L. Washburne, 4516 York Blvd., Los Angeles, Calif.

REFUSE RECEPTACLE—Having a removable flexible container adapted to receive for temporary storage waste paper or other refuse deposited into the container through a cover movably mounted. Patent 1692287. Samuel D. Bundy, 361 East Alvarado Ave., Pomona, Calif.

SAFETY RAZOR—Which may be produced at a comparatively low cost, the novel features of construction resulting in a saving of material, and very narrow blades being required. Patent 1694337. Jacob Oberheim, 1753 3rd Ave., New York, N. Y.

PROCESS OF FORESTALLING LEAKAGE IN CONCRETE RESERVOIRS—Which consists in subjecting the walls to violent contraction by the application of ice water, with resultant separa-

When Does Depreciation Start?

THE older a patent is, the less it is worth. Each year of its life it is worth less than the year before, because it has one year less to run. But what of an application for a patent?

A patent application is an assignable property right, capable of having a definite value placed upon it, just the same as a patent. The value of an application, furthermore, constitutes evidence of the value of the stock of the corporation for which the rights in the corporation were exchanged. Does, then, the patent application depreciate in value as time goes on, just as the patent does? The Hershey Manufacturing Company thought so, but the Board of Tax Appeals thought otherwise recently, when the Hershey company sought to recover a portion of its tax.

Back in March, 1919, O. S. Hershey, a machinist and tool maker, conceived an idea for a theft-proof automobile lock designed to be secured to the steering column within easy reach of the driver. It was a distinct improvement, for the driver could lock the gears without shifting his position, and the car could not be stolen by means of towing.

Hershey applied for a patent and with his brother and some friends formed a corporation. Three hundred locks were made and they sold readily at six dollars each. The Denver representative of the Cadillac Motor Company bought 25 to put on the cars he sold. Salesmen took orders for 600. The list price was 12 dollars per lock, with 50 percent off to jobbers. Everything considered, the net profit on each lock was estimated to be one dollar. The Underwriters Laboratories approved the lock as entitling owners whose cars were equipped with the device to a 15 percent reduction in insurance rates.

Automobile production was on the increase and it was estimated that 1,000,000 locks easily could be sold in the next ten years. A half million dollar corporation was formed; the rights in the patent application, which still was pending, were estimated to be 250,000 dollars. The patent application was the company's one big asset.

Orders began to pour in and the expectations of the incorporators were far exceeded. The first quantity order came in 1920; it was for 25,000 from the Simplex Corporation, and the net profit amounted to $1.75 instead of a dollar. Automobile manufacturers were approached and they began to adopt it as built-in standard equipment. By 1924 it was standard equipment on models of the Studebaker, Paige, Buick, Lincoln, Chevrolet and Jordan. In eight and a half years the Hershey company sold 2,500,000 locks, built its own factory and reached an output of a million locks a year.

In the beginning, when the rights in the patent application were exchanged for stock, they were estimated as 75,000 dollars. When the corporation was making a report for tax purposes in 1922, it claimed depreciation on account of the Hershey patent in the amount of $8,578.43, of which only $61.22 was allowed. In 1923 the depreciation deductions claimed amounted to $14,705.88, all of which was disallowed. The Hershey company appealed to the Board of Tax Appeals.

In refusing to allow the claim, Judge Siefkin declares:

"While it is very common today for assignments of inventions to be made prior to issue of the patent therefor, strictly speaking, an invention is not an assignable monopoly until its ownership is fixed. The only method of establishing a *prima facie* ownership is by obtaining a patent.

"It is elementary that an asset which has no definite period of useful life is not the proper subject of exhaustion, as one of the essentials to measuring the deduction is unknown. The period covered by application pending is a variable factor. Furthermore, the date the patent issues marks the beginning of the asset in use in an enforceable right, as well as fixes its life. It follows that the inchoate right represented by a patent application matures into a depreciable asset beginning with the date the patent is issued and extending over the 17-year period covered thereby."

MEANS FOR SEALING EXPANSION JOINTS—In concrete reservoirs, by filling the joint with a relatively soft and non-hardening compound, waterproofing the filling, and covering the joint with asphalt, pitch or the like. Patent 1691402. Eugene R. Oden, North Hollywood, Calif.

MANICURING IMPLEMENT—A three-in-one device which takes the place of the cotton wad, rosewood stick and cuticle bottle, also having means for supplying liquid medicaments, yet compact in form. Patent 1694336. John R. Neidig, Conrad, Mont.

INLET BOX—For chutes in houses, apartments, etc., which will prevent the escape of odors, and will operate to close the chute when the inlet box is opened. Patent 1694347. Harold D. Symonds and Harry J. Cullen, 278 W. 150th St., New York, N. Y.

BUILDING—A fire resisting construction for garages, schools or other purposes, wherein alternating floors are disposed at half-story intervals, and the ramps or stairs are enclosed by walls. Patent 1694309. Charles W. Buckham, 551 5th Ave., New York, N. Y.

UMBRELLA RIB AND SPREADER STRUCTURE AND METHOD OF PRODUCING THE SAME—Comprising hinging an end of one sheet of material to a medial portion of another sheet of material and longitudinally cutting the sheets to produce rib and spreader units. Patent 1693948. Frank Fabbrin, c/o Continental Products Co., attention Mr. Miller, 149 Broadway, New York, N. Y.

COSMETIC-PAD HOLDER—Wherein the bottom of the pan-shaped holder is formed with indentations presenting retaining means for resiliently supporting the pad. Patent 1694325. William G. Kendall, 118 Market St., Newark, N. J.

LAMP-SHADE-FRAME Holder—Adapted to be incorporated in and become an integral part of the wire lamp shade frame so that a lasting connection may be obtained. Patent 1695223. Kornel C. Berger, 365 First Ave., New York, N. Y.

BOX—A relatively fragile box, constructed of light cardboard, or paper, and reinforced for holding sheets of material so that they may be readily manually removed. Patent 1695143. Benjamin. L. Drapeau, c/o Standard Abrasive Co., 449 Pacific Ave., Jersey City, N. J.

TOOTH CLEANER—A support for holding thread dental floss or other material for thoroughly cleaning between the teeth and removing particles which cannot be dislodged by the brush. Patent 1695238. Godel Kalenoff, 1428 56th St., Brooklyn, N. Y.

VAPOR EXTRACTOR—To be applied upon towers in combination with the parts used for the extraction of gases and vapors from liquids, and the distillation of liquids. Patent 1695192. Meinhard H. Kotzebue, 1526 So. Victoria St., Tulsa, Okla.

SHINGLE—Which may be cut from a roll of roofing, having interlocking slits, which assure against curling, warping or other stresses, and requiring a minimum of securing elements. Patent 1696120. James E. Hooker, 311 Barnett National Bank, Jacksonville, Fla.

COMBINED WATER BAG AND FOOD COOLER—Constructed of flexible material with a double wall arrangement, the space being filled with water performing the functions of a cooler and drinking water supply. Patent 1696138. John W. and Harold K. Day, Box 870, Pocatello, Idaho.

SHIP—Equipped with devices which will not only result in saving lives, but will carry buoys for facilitating the location, and guide the lifting lines to the ship, if submerged. Patent 1696053. Jerome Pasini, 94 Baxter St., New York, N. Y.

WALL LOUVER VENTILATOR—A metal and wire screen device adapted to be readily inserted in a wall; particularly for the ventilation of cold

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Royalties at Last

TO Rufus Rand, builder of the new 25-story skyscraper in Minneapolis, we take off our hat. Announcement is made that, without obligation of any kind, he is paying a royalty to Leroy S. Buffington, inventor and patentee of the steel skeleton type of building construction. Buffington's patent was issued 41 years ago; it expired 24 years ago.

Buffington, educated in Cincinnati as a civil and mechanical engineer, went to Minneapolis in 1873, where he designed many public buildings, including 42 hotels, buildings at the University of Minnesota, the old State Capitol, the Pillsbury flour mills, the Union Station in St. Paul and the Boston Block. In 1880 he began to make drawings for what he called a cloud-scraper. In these, a masonry veneer was supported at each successive story on an iron shelf. This is the structural difference between the modern skyscraper and the old-fashioned type of building.

Two years later Buffington drew his first perspective of a 28-story cloud-scraper and in 1887 filed his application for a patent. On May 22, 1888, patents were issued in the United States, England, Germany, France and other countries. Later he formed the Buffington Iron Building Company to further the interests of the Buffington patent. Others began using the Buffington method and in 1894 suits for infringement were begun. Lawsuits, however, have a way of dragging on and on and before they terminated the inventor had spent 30,000 dollars in their prosecution and the patents expired.

All Buffington asked for the use of his system of buildings was a royalty of ⅛ of 1 percent, but nobody ever paid it. His sole reward seemed to be the knowledge that he had advanced civilization by his invention. Three years ago Rand, the grandson of a friend of Buffington, planned to erect a skyscraper. He had heard of the inventor, and, although he had never met him, resolved to pay him a royalty of ⅛ of 1 percent on the 1,800,000 dollar building he was planning. This would amount to just 2250 dollars.

When announcement was made recently that the check was forthcoming, the inventor could hardly believe his ears. Forty-eight years ago he had been called a crank and a dreamer. When architects and builders recognized the value of his method they wriggled out of paying. Now, when he is over 89 years old, when there is no legal obligation of any kind, his first royalty check appears.

closets, bath-rooms, or the like. Patent 17164. (Re-issue.) Robert J. Miller, 2519 11th Ave., Oakland, Calif.

LOOSE-LEAF BINDER—Which comprises a pluralty of wires fashioned into separate split rungs to grip more firmly when stress is applied, and to prevent accidental opening of the rings. Patent 1694846. Frederick A. Diestelkamp, Lowell, Oregon.

JAR CAP—Which may be detachably associated with the neck of a mustard or other container so that it may be removed, cleaned, sterilized and replaced at intervals. Patent 1696719. August A. Lundeen, Lynbrook, L. I., N. Y.

FRAME FOR PHOTOGRAPHIC FILMS—Comprising a frame, the longitudinal and end members of which have marginal flanges for receiving, guiding and holding an individual cut film, and retaining the same flat. Patent 1695644. Merle F. Faber and Joseph Kusber, c/o M. F. Faber, 14 Gambetta Ave., Daly City, Calif.

DESPENSING FAUCET—Including means for forming an opening in a container, and sealing the faucet in said opening, while allowing for removal when contents of container are completely dispensed. Patent 1696687. Martin Narbo, 5317 Seventh Ave., Brooklyn, N. Y.

MOLD-FORM STRUCTURE—A corner mold-form by means of which concrete or other plastic material may be shaped to form wall structures, and means for alining abutting sections. Patent 1696700. Harold R. Suiter, c/o Concrete Form Co., 326 Mt. Vernon Ave., N. W., Grand Rapids, Mich.

GOLF-CLUB CARRIER—Which is lighter than the ordinary bag, is open, therefore preventing the accumulation of dirt, and in which the clubs are independently supported, and balls carried. Patent 1696062. Lewis K. Thurlow and John P. Agnew, 1181 East 19th St., Brooklyn, N. Y.

Hardware and Tools

GRINDING TOOL—Having a plurality of radially movable grinding elements which are adapted to be controlled in their movement by a spring connected with a cam shaft. Patent 1693778. Louis Engman, 1723 3rd Ave., Moline, Ill.

BITT—Formed of any suitable metal, for application to a boat or wharf, whereby a rope or line may be readily secured without the necessity of knots or hitches. Patent 1694312. James H. Clark, Room 1771, Woolworth Bldg., New York, N. Y.

HANGING DEVICE FOR SCREENS—Adapted for supporting and securely holding a window screen in position, maintaining the screen snugly in engagement with the frame, and preventing rattling and displacement. Patent 1695764. Russell S. Holcomb, 3126 West Ave., 32d, Los Angeles, Calif.

TOOL FOR CUTTING VALVE SEATS—Which may be disposed in a vertical position, or at an angle to the vertical, for cutting valve seats, and providing countersunk pockets to receive the seats. Patent 1693767. Sylvester Smith, 917 Main St., Reedley, Calif.

COMBINATION TOOL FOR WELL-DRILLING OPERATIONS—Adapted for use in recovering lost tools, or other objects from a well, and for cutting off irregular ends of tools or pipes, to facilitate their recovery. Patent 1693789. George F. LeBus, Electra, Texas.

PORTABLE BENCH SAW—Which includes a supporting unit and an adjustable power unit, will perform a variety of functions, will occupy but small space, and can be conveniently transported. Patent 1695188. Fay M. Henkel, 16 Stenvenson Blvd., New Rochelle, N. Y.

TUNING HAMMER—Which provides sufficient leverage to turn a pin without flexing it, and facilitates the ease with which a pin can be adjusted to accurately tune a piano string. Patent 1693292. William Frauenberger, 2260 Glendale Blvd., Los Angeles, Calif.

LATCH—Of simple and durable construction, readily applied to a closure and its frame, and quickly convertible from a latch to a "night latch," or vice versa. Patent 1693912. Walter E. Worthen, 8106 Norton Ave., West Hollywood, Calif.

PIPE COUPLING—In which all screwed or threaded connections are eliminated, and will serve the purpose of a suction pipe, for use in connection with rotary drill outfits, without leakage. Patent 1696134. Harry D. Algyre, Box 476, Holdenville, Okla.

COMPOSING STICK—In which the stop may be adjusted for designating the number of picas, and any number of points which divide the picas into equal parts. Patent 1693105. Walter C. Bignold, 428 8th Ave., San Francisco, Calif.

Heating and Lighting

HEATING APPARATUS—An electric heating device removably positioned for transmitting heat for heating water within the boiler for hot water or steam radiator systems, without a coal or oil furnace. Patent 1696078. Joseph De Ruvo, 2347 Prospect Ave., Bronx, New York.

APPARATUS FOR PROJECTING LIGHT—Particularly a beam of light for theatrical, dental or surgical uses, and for illuminating fields of given shape and size, on works of art, advertising, etc. Patent 1695556. Harold A. McGunnigle, c/o Artlike Co., 739 Madison Ave., New York, N. Y.

Machines and Mechanical Devices

LOADER—Adapted to be removably connected with a truck, and to be actuated by forward or rearward movement of the truck for the loading and dumping of material. Patent 1694344. Joseph J. Koelbel, 219 S. Grand Ave., Baldwin. L. I., N. Y.

COMBINED COAL STOKER AND BURNER—Which forces air downwardly upon the fuel in the fire box, means being provided to feed the fuel to the burning area through an automatic stoker. Patent 1694290. John C. St Clair, 313 St., Granite St., Butte, Mont.

LIQUID-DISPENSING CONTAINER—Having a leak-proof-pouring spout cooperating with the closure discharge opening, and seating within the container when not in use, but projecting therefrom for pouring. Patent 1694304. George J. Armstrong, Maple Creek, Sask., Canada.

ROTARY PUMP—A simple construction which may be placed in an oil well for bailing the water and removing mud from the hole without setting the usual casing. Patent 1694329. John E. LeBus, Electra, Texas.

CASH-FARE MANIPULATOR—A simple and reliable device for compactly housing a book of tickets, with means for neatly removing portions of the tickets, to indicate the amount of fare paid. Patent 1694285. William D. Scalf, Pineville, Ky.

GAS-MAIN STOPPER—Comprising a collapsible and expansible diaphragm and frame, adapted to be passed through an opening in a gas main and expanded to cut off the flow of gas. Patent 1695187. Patrick Goodman, 523 Atlantic Ave., Brooklyn, N. Y.

OIL SAVER—Adapted to be associated with the drain opening in the bottom of a tank for saving the lower oil, without permitting the sediment to mingle with the oil. Patent 1694471. Norbert J. Jacobi, Box 143, Electra, Texas.

BED ATTACHMENT—In the form of a mechanism which not only permits the occupant to raise himself to a sitting or inclined position but to elevate and flex the legs. Patent 1693320. Turner B. Smith and James E. Bixler, 101 East Anaheim, Wilmington, Calif.

SAND-TESTER PUMP—In which no rods or lines are employed for removing the sand for testing, the pump maintaining sufficient suction for removing the mud and water from the sand. Patent 1696096. George F. LeBus, Electra, Texas.

MACHINE FOR CASTING CURVED STEREOPLATES—In which a cock is used to control the flow of molten metal, and which provides for reducing the distance between the matter and the edge of the plate by a novel arrangement of the cock bearing. Patent 1694299. Carl Winkler, Bern, Switzerland.

Medical and Surgical Devices

PAD AND BED VESSEL—In which the cushion is presented to support certain parts of the patient's body without discomfort, the pad and vessel are easily connected and disconnected. Patent 1695160. Amelia C. Sherran, 56 Menahan St., Brooklyn, N. Y.

Prime Movers and Their Accessories

CARBURETOR—Which may be fed, if necessary, from a fuel tank directly below it, and wherein the liquid fuel is caused to change its direction while in the presence of moving air. Patent 1696711. Frank C. Givens, Clara B. Givens, Administratrix, Box 666, Tuolumne, Cal.

SIGNALING DEVICE—For use in internal combustion engines, to automatically and visibly indicate when, for any reason, the water ceases to flow through the cooling system. Patent 1693309. Arthur L. Mettler, Route 1, Box 32, Somita, Calif.

Pertaining to Vehicles

SWIVELED AXLE FOR MOTOR CARS—Which prevents wear of pneumatic tires due in ordinary services, to the movement to and from each other of the wheels connected by the usual parallelogram system. Patent 1694305. Enrico Ascarelli, c/o Barzano & Zanardo, 9 Via Due, Marcelli, Rome, Italy.

ADJUSTABLE SEAT FOR AUTOMOBILES—Which may be adjusted toward or away from the foot and arm operated instruments, such as the pedals and steering wheel, to suit the driver's bodily dimensions. Patent 1693120. William J. Rhyner, Box 153, Salinas, Calif.

APPARATUS FOR CLEANING AND POLISHING AUTOMOBILES—A revolving platform which will permit a plurality of automobiles to be successively introduced to, and selectively discharged from, the point of treatment, for exterior or interior cleaning. Patent 1694120. Bee K. Gillespie, 231 So. La Salle St., Chicago, Ill.

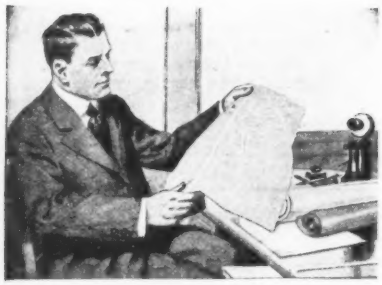
ELECTRIC SIGNAL-TRANSMITTING SWITCH—For the direction indicators of motor vehicles, whereby the intended signal may be set in operation and held for a determined period, whereupon it is automatically rendered inoperative. Patent 1695148. Dewey L. Harrison, 2015 Maryland St., Dallas, Texas.

MUDGUARD FOR MOTOR VEHICLES—Characterized by a screen consisting of a rigid portion maintaining at its lower edge a flexible member, and springs serving to maintain the mudguard in middle position. Patent 1695247. Henri Dedisse, c/o Office Picard, 97 Rue St., Lazare, Paris, France.

AUTOMOBILE DOOR POCKET—Which can be built into a door as a permanent part thereof, and is characterized by providing for quick accessibility for placing in, and removing articles therefrom. Patent 1694855. George C. Irons, 2367 Second St., La Verne, Calif.

MEASURING AND DISPENSING RECEPTACLE—For use in servicing automobile crankcases with lubricating oil, whereby the flow may be controlled, and the liquid measured as it is dispensed. Patent 1696079. Charles B. Doolin, c/o Mohawk Tire Supply Co., 212 Dallas St., San Antonio, Texas.

RESILIENT WHEEL—Presenting the general appearance of a pneumatic tire while actually being formed of a series of overlapped segments resiliently supported on the body of the wheel. Patent 1695629. Jack Allen, c/o Stern, 2165 71 St., Brooklyn, N. Y.



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